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ABSTRACT

One of a series of educational packages designed for implementation either in a workshop atmosphere or through individual study, this Hot Topic guide presents a variety of materials to assist educators in designing and implementing classroom projects and activities centering on the topic of the Internet and the K-12 classroom. The Hot Topic guide contains guidelines for workshop use; an overview of the Internet and the K-12 classroom; and 6 articles (from scholarly and professional journals) and ERIC documents on the topic. A 40-item annotated bibliography of items in the ERIC database on the topic is attached. (RS)

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ED 389 015

HOT TOPIC

GUIDE 58

The Internet and the K-12 Classroom

This Hot Topic Guide is one of a series of educational packages designed for implementation either in a workshop atmosphere or through individual study. With the comments and suggestions of numerous educators, the Hot Topic Guide series has evolved to address the practical needs of teachers and administrators. As you take the time to work through the contents of this guide, you will find yourself well on the way to designing and implementing a variety of classroom projects and activities centering on this topic.

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The Internet and the K-12 Classroom
by Christopher Essex

ARTICLES AND ERIC DOCUMENTS

- New Ways to Learn (and Associated Articles)
- Answers to Commonly-Asked Primary and Secondary School Internet User Questions
- Case Studies of K-12 Educators' Use of the Internet: Exploring the Relationship between Metaphor and Practice
- Using the Worldwide Web to Build Learning Communities in K-12
- Global Communications through Electronic Mail Systems
- An Introduction to Internet Resources for K-12 Educators

BIBLIOGRAPHY
A collection of selected references and abstracts obtained directly from the ERIC database.

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Series Editors: Dr. Carl B. Smith, Eleanor Macfarlane, and Christopher Essex

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In-Service Workshops and Seminars:
Suggestions for Using this Hot Topic Guide as a Professional Development Tool

Before the Workshop:

- Carefully review the materials presented in this Hot Topic Guide. Think about how these concepts and projects might be applied to your particular school or district.
- As particular concepts begin to stand out in your mind as being important, use the Bibliography section (found at the end of the packet) to seek out additional resources dealing specifically with those concepts.
- Look over the names of the teachers and researchers who wrote the packet articles and/or are listed in the Bibliography. Are any of the names familiar to you? Do any of them work in your geographical area? Do you have colleagues or acquaintances who are engaged in similar research and/or teaching? Perhaps you could enlist their help and expertise as you plan your workshop or seminar.
- As you begin to plan your activities, develop a mental "movie" of what you'd like to see happening in the classroom as a result of this in-service workshop or seminar. Keep this vision in mind as a guide to your planning.

During the Workshop:

- Provide your participants with a solid grasp of the important concepts that you have acquired from your reading, but don't load them down with excessive detail, such as lots of hard-to-remember names, dates or statistics. You may wish to use the Overview/Lecture section of this packet as a guide for your introductory remarks about the topic.
- Try modeling the concepts and teaching strategies related to the topic by "teaching" a minilesson for your group.
- Remember, if your teachers and colleagues ask you challenging or difficult questions about the topic, that they are not trying to discredit you or your ideas. Rather, they are trying to prepare themselves for situations that might arise as they implement these ideas in their own classrooms.
- If any of the participants are already using some of these ideas in their own teaching, encourage them to share their experiences.
- Even though your workshop participants are adults, many of the classroom management principles that you use every day with your students still apply. Workshop participants, admittedly, have a longer attention span and can sit still longer than your second-graders; but not that much longer. Don't have a workshop that is just a "sit down, shut up, and listen" session. Vary the kinds of presentations and activities you provide in your workshops. For instance, try to include at least one hands-on activity so that the participants will begin to get a feel for how they might apply the concepts that you are discussing in your workshop.
- Try to include time in the workshop for the participants to work in small groups. This time may be a good opportunity for them to formulate plans for how they might use the concepts just discussed in their own classrooms.
- Encourage teachers to go "a step further" with what they have learned in the workshop. Provide additional resources for them to continue their research into the topics discussed, such as books, journal articles, Hot Topic Guides, teaching materials, and local experts. Alert them to future workshops/conferences on related topics.

11/94

After the Workshop:

- Follow up on the work you have done. Have your workshop attendees fill out an End-of-Session Evaluation (a sample is included on the next page). Emphasize that their responses are anonymous. The participants' answers to these questions can be very helpful in planning your next workshop. After a reasonable amount of time (say a few months or a semester), contact your workshop attendees and inquire about how they have used, or haven't used, the workshop concepts in their teaching. Have any surprising results come up? Are there any unforeseen problems?
- When teachers are trying the new techniques, suggest that they invite you to observe their classes. As you discover success stories among teachers from your workshop, share them with the other attendees, particularly those who seem reluctant to give the ideas a try.
- Find out what other topics your participants would like to see covered in future workshops and seminars. There are nearly sixty Hot Topic Guides, and more are always being developed. Whatever your focus, there is probably a Hot Topic Guide that can help. An order form follows the table of contents in this packet.

Are You Looking for University Course Credit?

Indiana University's Distance Education program is offering new one-credit-hour Language Arts Education minicourses on these topics:

Elementary:
Language Learning and Development
Varied Writing Strategies
Parents and the Reading Process
Exploring Creative Writing with Elementary Students

Secondary:
Varied Writing Strategies
Thematic Units and Literature
Exploring Creative Writing with Secondary Students

K-12:
Reading across the Curriculum
Writing across the Curriculum
Organization of the Classroom

Course Requirements:

These minicourses are taught by correspondence. Minicourse reading materials consist of Hot Topic Guides and ERIC/EDINFO Press books. You will be asked to write Goal Statements and Reaction Papers for each of the assigned reading materials, and a final Synthesis paper.

I really enjoyed working at my own pace.... It was wonderful to have everything so organized...and taken care of in a manner where I really felt like I was a student, however "distant" I was...."
--Distance Education student

Three-Credit-Hour Courses are also offered (now with optional videos!):

Advanced Study in the Teaching of:
- Reading in the Elementary School
- Language Arts in the Elementary School
- Secondary School English/Language Arts
- Reading in the Secondary School

Writing as a Response to Reading
Developing Parent Involvement Programs
Critical Thinking across the Curriculum
Organization and Administration of a School Reading Program

For More Information:

For course outlines and registration instructions, please contact:

Distance Education Office
Smith Research Center, Suite 150
2805 East 10th Street
Bloomington, IN 47408-2698
1-800-759-4723 or (812) 855-5847

Planning a Workshop Presentation
Worksheet

Major concepts you want to stress in this presentation:

1) ______________________________

2) ______________________________

3) ______________________________

Are there additional resources mentioned in the Bibliography that would be worth locating? Which ones? How could you get them most easily?

Are there resource people available in your area whom you might consult about this topic and/or invite to participate? Who are they?

What would you like to see happen in participants' classrooms as a result of this workshop? Be as specific as possible.

Plans for followup to this workshop: [peer observations, sharing experiences, etc.]

Agenda for Workshop
Planning Sheet

Introduction/Overview:

[What would be the most effective way to present the major concepts that you wish to convey?]

____

____

____

Activities that involve participants and incorporate the main concepts of this workshop:

1) ______________________________

____

____

____

2) ______________________________

____

____

____

Applications:

Encourage participants to plan a mini-lesson for their educational setting that draws on these concepts. [One possibility is to work in small groups, during the workshop, to make a plan and then share it with other participants.]

Your plan to make this happen:

____

____

Evaluation:

[Use the form on the next page, or one you design, to get feedback from participants about your presentation.]

END-OF-SESSION EVALUATION

Now that today's meeting is over, we would like to know how you feel and what you think about the things we did so that we can make them better. Your opinion is important to us. Please answer all questions honestly. Your answers are confidential.

1. Check (✓) to show if today's meeting was

   ☐ Not worthwhile ☐ Somewhat worthwhile ☐ Very worthwhile

2. Check (✓) to show if today's meeting was

   ☐ Not interesting ☐ Somewhat interesting ☐ Very interesting

3. Check (✓) to show if today's leader was

   ☐ Not very good ☐ Just O.K. ☐ Very good

4. Check (✓) to show if the meeting helped you get any useful ideas about how you can make positive changes in the classroom.

   ☐ Very little ☐ Some ☐ Very much

5. Check (✓) to show if today's meeting was

   ☐ Too long ☐ Too short ☐ Just about right

6. Check (✓) whether you would recommend today's meeting to a colleague.

   ☐ Yes ☐ No

7. Check (✓) to show how useful you found each of the things we did or discussed today.

   Getting information/new ideas.

   ☐ Not useful ☐ Somewhat useful ☐ Very useful

   Seeing and hearing demonstrations of teaching techniques.

   ☐ Not useful ☐ Somewhat useful ☐ Very useful

   Getting materials to read.

   ☐ Not useful ☐ Somewhat useful ☐ Very useful

Listening to other teachers tell about their own experiences.

☐ Not useful ☐ Somewhat useful ☐ Very useful

Working with colleagues in a small group to develop strategies of our own.

☐ Not useful ☐ Somewhat useful ☐ Very useful

Getting support from others in the group.

☐ Not useful ☐ Somewhat useful ☐ Very useful

8. Please write one thing that you thought was best about today:

9. Please write one thing that could have been improved today:

10. What additional information would you have liked?

11. Do you have any questions you would like to ask?

12. What additional comments would you like to make?

Thank you for completing this form.

The Internet and the K-12 Classroom

by Christopher Essex,
Indiana University

The Internet, it has been argued, is perhaps the most exciting technological advance in communication since the invention of television, and so it is not surprising that, just as many educational uses have been found for television--from simply presenting regular broadcast educational television programs like *Sesame Street*, to playing videotapes, to presenting entire college courses--new uses are being found for using the Internet in the elementary and secondary classroom. This reader will present some of the possible uses that have been found for network-based telecommunications in the K-12 classroom. The emphasis in this guide is not, like many other publications, simply a listing of e-mail and Worldwide Web (WWW) addresses, though we have included an article with that information. Rather, it collects and presents classroom activities that an educator can directly utilize with his/her own students.

Setting Up Your Internet-Connected Classroom

In order to use these activities, some familiarity with your school's computer hardware and software (or some familiarity with someone who knows about them) is necessary, as it is outside the scope of this publication to discuss specific questions like "How do I get onto the Internet?" or "How can my school get e-mail?" As there have been many published books and articles on this subject already, it is assumed that this information will have been already procured by the reader.

Regarding legal issues and the Internet, we have included an article dealing with some of the legal implications of allowing children access to its resources.

Using the Internet in the Classroom

Many educators' primary experience of the Internet is limited to sending and receiving e-mail and perhaps browsing the goods and services offered on an online service such as Prodigy, CompuServe or America Online. It may seem at first, with these experiences as a background, that the possibilities for using the Internet in the classroom are limited. Sending e-mail is interesting, but wouldn't kids learn as much by writing a regular letter to someone? And the online services so often seem to be just an electronic shopping mall; surely children have enough exposure to sales messages as it is. So what can students do on the Internet that has enough educational value to override the costs and difficulties of establishing an Internet connection in the classroom?

Well, here are some ideas for starters:

- Correspond with e-mail pen pals around the world
- Mentoring--have an expert in a field answer children's questions
- Collaborative work between distant students on a given project
- Contacting important figures--send e-mail to company CEOs, government officials
- College AP courses by Distance Education for secondary students
- Send e-mail to disabled and elderly people
- Find mailing lists and newsgroups on appropriate subjects
- Visit The White House, Library of Congress, Art Museum Worldwide Web homepages.
- Visit the homepages of other elementary and secondary schools

Each of these projects, and many others, could be easily accomplished by using the various Internet resources which I will outline in the next section.

The Types of Internet Services

The primary services available on the Internet are:

1. **E-mail.** This is a service that allows you to send and receive messages over the Internet. You can send these messages to an individual's e-mail account, or to a group of people via a mailing list, or both.

2. **Newsgroups.** USENET newsgroups have been established for almost any topic that could possibly discussed by a group of people, and more groups are being started every day. You need a newsreader program to read these newsgroups and to contribute to them.

3. **Worldwide Web.** The Worldwide Web (WWW) allows you, if you have a Worldwide Web 'site' or permission to add your own 'pages' to an existing site, to put text, pictures, video and sound on the Internet. You need a Worldwide Web browser program to access the Worldwide Web and its resources.

4. **Commercial Online Services.** Commercial online services are somewhat like the Worldwide Web, in that they (usually) have many different sections to explore and are layered with various kinds of multimedia. Primary differences are that online services provide their own 'browser' program and they are owned by one company (while the Worldwide Web itself is owned by no one). You cannot access, say, America Online services if you are a Prodigy subscriber.

It is important to note that there is some overlapping of categories here. For instance, an Online service such as America Online offers its subscribers Internet e-mail access, USENET newsgroups (as well as its own in-house newsgroups), and Worldwide Web access. Also, many if not all major universities have their own Internet service, and this is often a cheaper way for local elementary and secondary schools to get established on the Internet. The services provided by university systems may be more limited, however, than with a commercial online service. It is possible that your school may have an Internet account with a local university that only provides dial-in e-mail access, for instance. Also, they may or may not provide the necessary software, such as a Worldwide Web browser or a newsgroup reader.

Having these basic definitions down, then, it is important for an educator wanting to take his or her classroom online to keep in mind that these various forms of Internet communication are good (and bad) for different things. One cannot plan for a generic Internet activity; one must decide which service is most appropriate for the activity. Simply put, here are the services again, with a note as to what they are best at:

1. **E-mail.** Great for one-to-one or group communication. Messages can often be instantaneously transmitted from one user to another over large expanses of geographical space. Mailing lists, either existing ones or lists specially created for the purpose, can allow a kind of Internet "classroom discussion" on a topic. And of course, in order to use e-mail, the student must use his or her reading and writing skills.

2. **Newsgroups.** At their best, newsgroups are a place where people with expertise and interest in a certain topic can pool their experience and information to advance our knowledge of that topic. At worst, they are collections of repetitious answers to basic questions, libraries of unverified data and unsubstantiated theory, and demonstrations of the fine art of the scatological insult. Many newsgroups (especially in the alt.sex hierarchy) have given the Internet an unsavory reputation, as they are full of homemade pornography of various forms. However, there are good and useful groups on various hobbies and interests, and groups set aside (though there is no way of enforcing this) for educators and kids (such as the K12. hierarchy of groups). Newsgroups' primary benefits to their readers are, I think, that they can provide up-to-the-nanosecond information on a given topic, and can accommodate an infinite variety of point of view on a subject. And, of course, everyone can contribute to the discussion.

3. **Worldwide Web.** The Worldwide Web is probably the most appealing and user-friendly of all the Internet services available. Full of colorful graphics, generally light on text, Web sites are beginning to look more and more like television. Except that on the Web, you can point and click and something happens. Maybe you watch (after a bit of waiting) a short video clip, or you hear a soundbite, or the images and words on the screen change and you are now somewhere else on the Web. The amount of pointing and clicking possible on the Web is as close to infinite as one could ask for; there exist many times more options, more destinations, than with an commercial online service such as America Online. Where money and technical assistance are available, many libraries, museums and art galleries have put images, video, and sound of some of their treasures for all to see on the Web, which

makes it a very attractive resource to educators who aren't geographically near these cultural institutions.

One potential downside is that these popular sites are often busy, especially during the school day, and due to the vagaries of Internet connections, it is not always possible to access them. Downloads of large graphic files, such as that wonderful large and detailed version of the Mona Lisa that you heard about, may take quite awhile, too.

Schools are also getting into the Web 'act,' setting up their own Web pages and including student artwork, stories, essays, etc. Virtually anything a student could do can be put up on the Web for all (potentially including distant relatives, other students in far-off places and others) in a kind of Internet art show or science fair. Putting material up on the Web is similar to publishing, and like publishing, requires a certain commitment in terms of money, equipment, time and effort. Unlike e-mail and newsgroups, Web publishing requires learning HTML (Hypertext Markup Language) which is like teaching students a new form of punctuation. Adding graphics, sound, and/or video require equipment and various software, as well.

4. **Commercial Online Services.** Commercial online services are beginning to actively court educational users, touting special rates, and they will provide the necessary software for free. All that is really needed, then, is a computer of sufficient power and speed and a modem that isn't too horribly slow. Individual commercial providers offer various services, but you may be able to do such things as access the Library of Congress database, contact seniors for penpal e-mail exchanges, download articles from magazines like Time and National Geographic, explore databases related to foreign countries, and other useful and educational activities.

Primary disadvantages of a commercial online service are cost (you will probably be paying by the hour) and limited areas that are appropriate for school activities (though with the new versions of many online services' software providing Worldwide Web access, this is less of an issue). Another disadvantage, at least as this is written, is that unlike the Worldwide Web, the avenues for contributing to a commercial online service are limited.

You cannot set up a school home page, for instance, at most of the commercial online services; interaction is limited to e-mail and newsgroups.

There are two aspects of Internet service that I have not mentioned yet:

1. **Gopher and FTP**: Gopher is a text-only, hierarchical precursor to the multimedia, nonhierarchical Worldwide Web. Most gopher sites are being replaced by Websites. Gopher files can be read through Worldwide Web browsers, and many financially-strapped institutions have simply put their gopher sites on the Web. FTP is a method for sending files from one computer to another, and is the method by which gopher files are sent and retrieved. Both of these aspects of the Internet are of limited use to most elementary and secondary educators.
2. **IRC and Chat.** E-mail may at times, related to the particularities of the Internet connection, be almost instantaneous, and messages and replies may fly back and forth at lightning speed. It is also possible to set up a kind of Internet 'conference call', where several people may engage in a conversation, their words appearing on the screen much like a movie script, with e-mail address name attributions to distinguish one person's words from another. This is possible both on the commercial online services (where chat rooms, both public and 'private' on all sorts of topics are a big draw) and on IRC (International Relay Channel), a noncommercial system, access to which is available on some university systems and a few commercial online providers. There is certainly education potential in this method of near-simultaneous Internet conversation--such as for distance learning courses--but there has been little exploration of this area because of cost and access issues.

Classroom Management and the Internet

One disadvantage of using computers in general in the classroom is that few school districts can afford to buy a computer for every child, or even every other child, in a classroom. So a student's time at the computer must be restricted so that all have fair and regular access to the computing resources. Because of this, computer-based activities work well as one of a series of 'centers' in a busy classroom. Also, new overhead projector and television adapters allow for the entire class to share in a computer-based activity. One important aspect of using the Internet in the classroom is to decide whether it is best designed for one or two children at a computer or the entire class viewing on a television or overhead projector.

Along with ensuring equal access to the computer for all students, I think it is important for a teacher to avoid using computer time as either a reward or a punishment. The computer, and the Internet, should be seen as just another tool for learning. Children need to be shown that the computer, and the Internet, are not to be scared of or to be fixated upon, but are just another way to use their creativity and knowledge and explore the creativity and knowledge of others.

Just like any other activity, a child's use of the Internet needs to be monitored. Regardless of whether the student is sending or receiving e-mail, reading a newsgroup, or accessing sites on the Worldwide Web, there is always the possibility of running into inappropriate or educationally unsound material. There are currently programs available, such as Surfwatch, that will automatically restrict access to certain newsgroups and Websites, and I would definitely recommend them to any educator who is allowing a child access to the Internet. However, there are always new sites and newsgroups that these programs will not censor, and so just leaving a student alone on a computer with one of these programs is no guarantee of anything. So, as always with children, you need to pay attention to what they are doing, whether on the Internet or not.

Guidelines for Internet Activities:

1. As with any other activity in the school day, *set some realistic educational outcomes for any Internet activity.* What is to be learned?
2. *Is the Internet the most appropriate technology for this activity?* And what Internet service is the most appropriate for the activity? As shown above, various aspects of the

Internet are good for various things. This difference can often be subtle but important. For instance, a report on, say, gun control laws, based on the discussion of the topic on the rec.guns newsgroup will often be different from a report based on materials found on the Bureau of Tobacco, Alcohol and Firearms' Website.

3. *Decide on how to present the activity.* Will it be an all-class activity, where we discuss items on a Website together as we view them on an overhead projector-computer setup? Or will the students explore the material at their own pace at a computer station?

4. *There are always software and hardware issues to consider.* Is there any part of the activity that will require disk storage of files? Do I want to access and download files before class, saving them on disk so that I can show them reliably and quickly to the class? If the classroom computers, as is often the fact, are configured differently (different hardware/software packages) will this affect the activity? Many older computers, for instance, are not powerful enough for accessing the Web, but do e-mail and newsgroups without any difficulty.

5. *Are the students doing something that is truly interactive?* Can this activity be on an interactive level that is more than just pointing and clicking? For instance, some Websites allow for various kinds of art projects to be designed. Other Websites have choose-your-own adventures, or add-on stories, where the child gets to assist in the construction of a work of fiction. Children passively consume enough entertainment in their out-of-school life; does this Internet activity actually require an active child?

6. *How can I evaluate the student's learning from this activity?* Can I ask the student to produce something creatively that he or she would not have been able to produce if they had not done this activity? Is there information that the student now knows that has been acquired through the Internet? Some Web sites have interactive quizzes or games to test a student's new knowledge. Obviously, all the tried and true means of assessment are also available to the Internet-connected classroom. Perhaps students could have an e-mail discussion on some topic found on the 'net, or could work on a

collaborative paper together, sending it back and forth from one student to the other as they do their revisions.

7. *Is the fact that the Internet allows for communication between people of different countries, ages, backgrounds and religions being considered in this activity?* The fact that the relatively simple and unglamorous Internet e-mail system allows this unprecedented opportunity for quick, often cheap, worldwide communication between individual people is often not considered by educators who are swept up by the corporately-sponsored glitz and glamour of commercial online services and expensively-designed Websites.

Obviously, not every Internet activity can answer each of these questions in a positive way, but with these considerations in the back of your mind as you plan your Internet-connected curriculum, it will be easier to construct appropriate educational activities for your students.

Cover Story

New Ways

As networking, multimedia, mobile technology, and better software converge, schools and companies are discovering new ways to improve learning, increase information access, and save money

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The refrain is all too familiar: For the past decade, educators and employers have been crowing about the enormous potential for CBET (computer-based education and training), but nearly everyone acknowledges that this potential has yet to be realized. Computers in the schools have soaked up huge capital expenditures without providing any appreciable return on investment. In companies, investments in information technology have been used mostly to automate old learning processes instead of to enable new ones.

That picture is starting to change, however, as new technologies begin making their way into schools and training centers. "The old pattern of kids left in the corner to do flash cards on an Apple II is over," says Jeanne Hayes, president of Quality Education Data, or QED, a research firm in Denver, Colorado. Explosive growth in CD-ROM drives, LANs and Internet connections, multimedia, and collaborative software environments is fueling a new wave of better teaching tools. This generation of technology promises more than just an improvement in educational productivity: It may deliver a qualitative change in the nature of learning itself.

New approaches to educating workers and students are arriving just in time, in the view of many experts. The changing nature of companies and the work they do, especially with large-scale downsizing and the shift to an information-based economy, is requiring workers to be more flexible and better trained, especially in the use of technology. Businesses require schools to turn out students with a different set of skills than those emphasized in early-twentieth-century pedagogy. And employers themselves are using new technologies to educate workers. "Organizations are linking learning to productivity, rather than [training] in advance of the act," says Robert Johansen, director of the new-technologies program at the Institute for the Future in Palo Alto, California, and coauthor of the book *Upsizing the Individual in the Downsized Organization* (Addison-Wesley, 1994). "This is what we call 'just-in-time learning,'" he adds.

Tectonic shifts in computer-assisted teaching mirror those occurring throughout the computer industry—for instance, away from centralized, host-based systems to a networked, distributed model. They also echo a new way of thinking in education theory: Instead of a one-way information flow—typified by broadcast TV or a teacher addressing a group of passive students—new teaching techniques are, like the Internet, two-way, collaborative, and interdisciplinary.

"All the uses of information technology in the last decade—computer-aided instruction, networked information, distance learning—have had problems," says Carol Twigg, vice president of Educom, a Washington, D.C.-based organization for technology in higher education. "The problem with all of them is that they were bolted onto current in-

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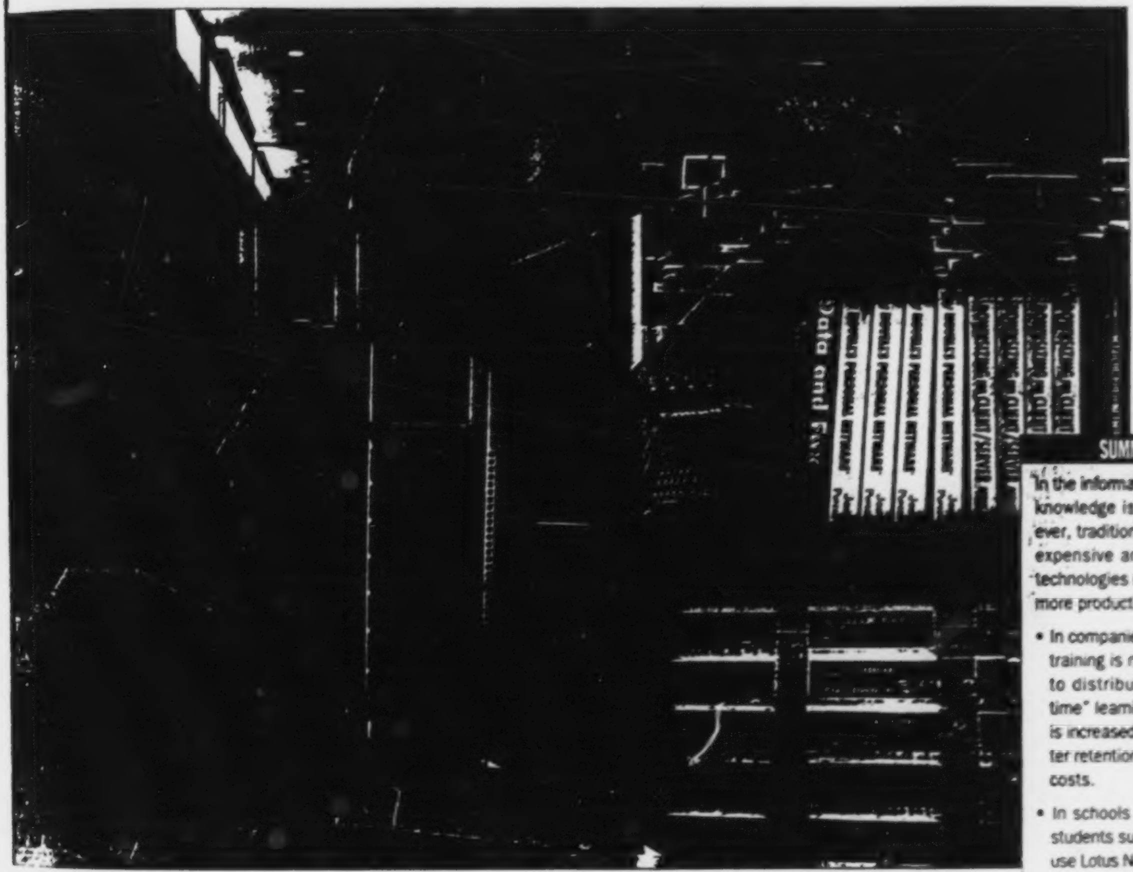
to Learn



SUMMARY

In the information economy, knowledge is power. However, traditional teaching is expensive and slow. New technologies make learning more productive.

- In companies, centralized training is now giving way to distributed, "just-in-time" learning. The result is increased flexibility, better retention, and lowered costs.
- In schools and colleges, students surf the Internet, use Lotus Notes, exchange E-mail, peruse multimedia CD-ROMs, and perform simulations. These techniques break down barriers, customize instruction, and make education more cost-effective.

ANDY REINHARDT

structional methods." The convergence of new technology and modern teaching practices is finally breaking that mold, as each enables the realization of the other.

Of course, penetration of technology into classrooms dramatically redefines established teacher-learner relationships. Teachers change from omniscient leaders into tour guides for the infosphere. Instructional materials evolve from rigid textbooks into customizable software. Information becomes more accessible, users pick and choose what they want, and everyone is a content creator. "Education on demand, in homes and on the job, will be a far bigger business than entertainment on demand," asserts R. Wayne Oler, president and CEO of International Thomson Publishing's Education Group in Belmont, California.

Growing Infrastructure

Indeed, education is already big business. The U.S. spends $275 billion yearly for kindergarten through high-school (i.e., K-12) education, or roughly 5 percent of the gross domestic product, according to QED. Of that, roughly $2.4 billion was spent on educational technology last year, says the Software Publishers Association of Washington, D.C.

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In its July 1994 *K-12 Education Market Report*, the SPA says that "more than half the schools in the country now use computers in almost every discipline." Ninety-nine percent of schools have at least one computer, says the International Association for the Evaluation of Educational Achievement. Unfortunately, only one-third of schools have more than one computer for every 10 students; the national average is 12 students per computer, down from 22 in 1989, says QED.

Technology spending in higher education is harder to pin down (e.g., How do you categorize computer purchases made by students?), but a report from IBM Academic Consulting pegs institutional spending at more than $6 billion for 1994. According to the report, American institutions of higher education have spent an estimated $70 billion on computer-related goods and services over the past 15 years; of that amount, as much as $20 billion was for teaching and learning technology.

The amount of money earmarked for corporate training is also huge. *Training* magazine, in its annual industry survey, estimates that U.S. corporations with more than 100 employees budgeted $51 billion for training in 1994. Arthur Gloster, vice provost for information technology for Virginia Commonwealth University in Richmond, estimates the total spent per year by all companies and their employees at $90 billion to $100 billion.

CHANGING EDUCATIONAL PARADIGMS

OLD MODEL	NEW MODEL	TECHNOLOGY IMPLICATIONS
Classroom lectures	Individual exploration	Networked PCs with access to information
Passive absorption	Apprenticeship	Requires skills development and simulations
Individual work	Team learning	Benefits from collaborative tools and E-mail
Omniscient teacher	Teacher as guide	Relies on access to experts over network
Stable content	Fast-changing content	Requires networks and publishing tools
Homogeneity	Diversity	Requires a variety of access tools and methods

New Learning

The common thread linking schools, colleges, and corporations is that all are facing budget pressures and are looking for ways to improve education's return on investment. "We're spending more and more on educational technology, but most of this spending is bolted onto our existing cost structure," says Bill Graves, associate provost for information technology at the University of North Carolina at Chapel Hill and director of the Institute for Academic Technology (Durham, NC). "We need to use the technology—use the network—to reduce costs and increase access," he adds.

Schools and companies are using similar technologies to address similar problems, because there is ample evidence that appropriate use of technology can boost retention rates, reduce boredom and misbehavior, and, in many cases, cut costs. The SPA's *Report on the Effectiveness of Technology in Schools, 1990-1994*, a summary of 133 studies, found that educational technology clearly boosted student achievement, improved student attitudes and self-concept, and enhanced the quality of student-teacher relationships.

Especially promising technologies were interactive video, networking, and collaboration tools. Computers are "amazingly patient teachers," says Jan Davidson, president and founder of software maker Davidson & Associates (Torrance, CA); they can spur creative thinking, promote enterprise, and whet curiosity.

But in study after study, another vital conclusion emerges: Technology alone is not the solution. Reaping the benefits of computers first requires extensive teacher training, new curricular materials, and, most important, changes to educational models. Modern educational concepts, derived from the work of scholars such as Swiss psychologist Jean Piaget, MIT researcher Seymour Papert, and Russian psychologist Lev S. Vygotsky, emphasize individualized, hands-on learning; teamwork; and guided discovery of information.

All these concepts are not only well suited to technology assistance, but, given the economics of teaching and training, they are nearly impossible to effect without the help of computers. Says Britton Manasco, editor of the *Learning Enterprise*, a newsletter about corporate education, "We have to tailor [learning] to the individual student or employee, but there's no way we can afford to do this without technology."

Another problem with today's education "is that people are learning in a large group, and they're afraid to speak out because the culture makes them feel foolish if they make a mistake," says professor Roger Schank, director of Northwestern University's Institute for the Learning Sciences (Evanston, IL). "The greatest value of computers is that they will watch out for you and let you do stuff without fear of embarrassment," he adds.

Schank sees computers as electronic mentors. "They can provide built-in experts that are available on-line, looking over your shoulder," he says. "So, instead of today's model, where you have one expert at the front of the room talking to a lot of people, it's reversed: You have one user at a computer with hundreds of experts built in."

This permits—and makes economically feasible—the return of a very old educational model: apprenticeship. "Apprenticeship has always been the best learning model, whether from other people or simulations," Schank says. "Computers allow apprenticeship in fields where it's hard or impossible to do it in real life, like surgery or learning to fly an airplane."

The implications of this transformation affect both students and teachers. Instructors become more like coaches, while students are free to discover knowledge on their own. "There is more information about topics these days than anybody can handle, so teachers have to rely on technology to help," says Anita Best, editor of the *Computing Teacher* magazine, published by the International Society for Technology in Education (Eugene, OR), or ISTE. With computers, "teachers become facilitators, collaborators, and brokers of resources. The networks have the information, but the students need a guide."

Computers are also a huge aid in preparing course materials, whether through conventional tools, such as word processing, desktop publishing, presentation, or illustration packages, or as a means of access to far-flung resources, ranging from Internet news groups to shareware lesson plans on AOL (America Online). "Making it easier to prepare materials means teachers can focus on explaining information instead of conveying information," says Robert Cavalier, a senior faculty consultant at the Center for the Advancement of Applied Ethics at Carnegie Mellon University (Pittsburgh, PA).

New Technologies

The emerging technologies that are making the biggest difference in training and education fall into three broad categories: networking, multimedia, and mobility. Networking includes LANs, WANs, and on-line services (especially the Internet), as well as applications enabled by networks, such as audio conferencing and videoconferencing, E-mail, collaborative software, and instructional management. "Telecommunications will probably have the most long-term impact on teachers and students," says Dr. Greg Kearsley, a professor of educational leadership at George Washington University, or GWU (Washington, DC), and a member of the Association for the Advancement of Computing in Education (or AACE), in Charlottesville, Virginia. "It's like word processing: It will become more a part of the infrastructure than an application in and of itself," he explains.

Networked applications run the gamut, from Internet survey courses to Lotus Notes–based collaborative projects. At the public schools in North Reading, Massachusetts, students use the Internet as a means of accessing authoritative sources, says Tom Hashem, a math teacher and the guiding light of the district's computer program. "It gives them access to timely information they couldn't find in the local library," he adds.

One high-school class studying an Amazonian tribe joined an anthropology list server and contacted ethnographers who were experts about the tribe. When they got contradictory responses, Dr. Maryanne Wolff, a teacher, says, it taught the students that informed sources sometimes

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Seven New Ways to Learn

Carnegie Mellon University is changing the way in which teachers teach and students learn

DENNIS BARKER

Carnegie Mellon University (Pittsburgh, PA) buzzes like a playground during recess period—except its researchers aren't playing. Carnegie Mellon computer scientists, cognitive psychologists, education experts, and professors are working on projects that can change the way teachers teach and students learn.

Building on its historic strengths in speech recognition and AI, Carnegie Mellon is advancing education along seven broad thematic lines:

- Simulating real-life environments (e.g., the stock market or a hospital ethics team)
- Enabling self-paced learning
- Lowering the intimidation factor (i.e., fear of looking stupid)
- Reducing behavioral problems in the classroom
- Increasing one-on-one interaction
- Providing access to more information
- Implementing "situated learning"

The FAST Program

The FAST (Financial Analysis and Security Trading) program uses computers and high-speed communications to simulate the fast-and-furious world of the stock market. (It's part of the Graduate School of Industrial Administration's degrees in computational finance and industrial administration, which aim to produce information-technology-savvy graduates.) The program, as dean Robert Sullivan puts it, uses computers to "create a competitive trading environment, where students learn by doing."

In the FAST lab are pairs of Hewlett-Packard Unix machines and Windows PCs. On the PCs are trading tools, electronic textbooks, and portfolio management programs. The Unix boxes and PCs are hooked up to a real-time data feed from Reuters that shows what's happening on the stock, money, and options markets. Students use this live data to buy and sell real stock at actual current prices. "The system greatly accelerates our students' transition from the classroom to the real, live trading floor," says Sanjay Srivastava, Graduate School of Industrial Administration professor of finance and economics and co-developer of the FAST program. It teaches them "how to react in a real environment," he adds.

Reading aloud is less intimidating and more fun with a computer-based coach.

Carnegie Mellon has extended this trading environment, as well as the reach of its teachers, by connecting to schools in Mexico City, Tokyo, and other locations via a packet-switching network. The ultimate goal is to create a "virtual university" by adding more schools and using technologies such as videoconferencing to offer the programs to students in other locations. "All the concepts of distance learning [and] distributed learning that we are implementing in this program are applicable to education in industry," says Sullivan.

PUMP Algebra Tutor

The Mac-based PAT (Pump Algebra Tutor) takes students in the Pittsburgh Urban Mathematics Project through practice sessions at their own pace as a way of teaching them how to solve math word problems. The software is currently being used in three Pittsburgh high schools.

PAT is built around a cognitive model that tracks a student's performance and guesses at how well a student is learning a lesson. When the student appears to have the relevant skills nailed down, the program presents the next level of problems. When stumped, the student can ask the tutor for hints. The program doesn't give the answer; instead, it prods with suggestions (e.g., "Have you tried doing X?").

"Students are much more comfortable with computers when it comes to a problem they're having trouble with," says Ken Koedinger, a Carnegie Mellon researcher involved with the tutor program. "They don't feel embarrassed when they give the wrong answer to the computer-based tutor." Students are also more involved in their work and aren't goofing around. "Teachers don't have to spend 70 percent of their time dealing with discipline," says Jaclyn Baker Snyder, head of the math department at Langley High School.

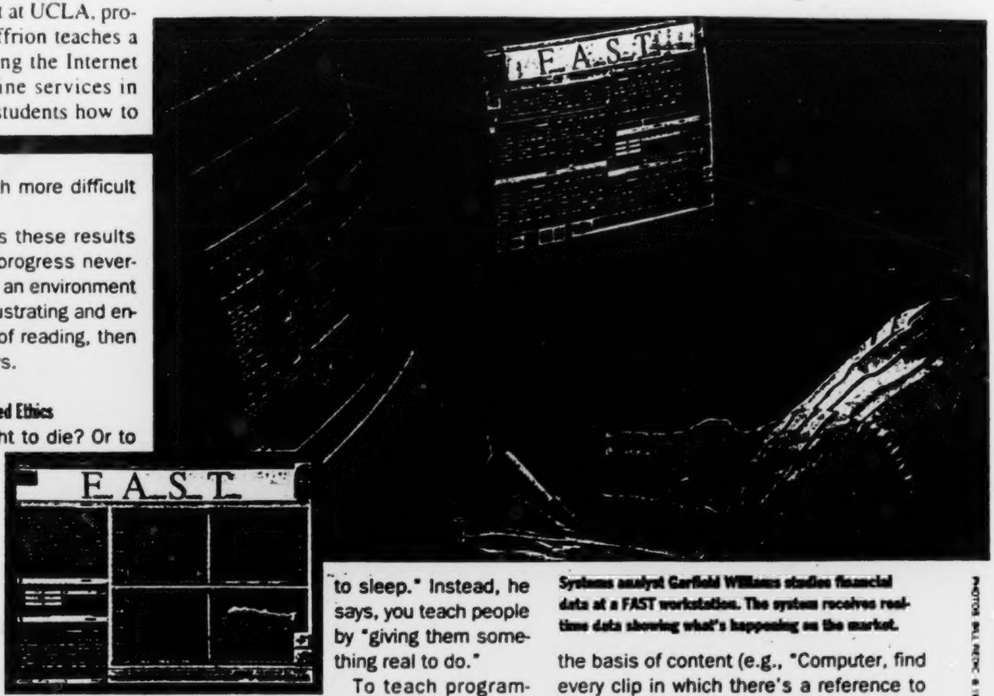
Project Listen

An AI-based coach program called Project Listen listens to kids read and then helps them out when they misread a word or apparently don't understand a sentence. The system, which is demonstrated on a Next computer equipped with a microphone, is linked to a speech recognizer developed at Carnegie Mellon, called Sphinx-II, that runs on an HP 735. It matches the spoken word with the text the student reads from and then highlights a problem word and pronounces it. "There's lots of software out there that tries to teach reading, but none of it is capable of listening and intervening," says senior research scientist Jack Mostow.

Eventually, he hopes, the coach will be smart enough to know what kinds of words a student has the most trouble with and then sprinkle them throughout the reading lesson. Although the coach is still "highly experimental," results have shown benefits. Preliminary experiments with a prototype showed that second-graders could read at a level six months higher, on average, while being assisted by the coach. Recent usability trials also suggest gains in comdisagree. "Students begin to learn the need to dig into the background and perspectives of their sources," she notes.

At the John E. Anderson Graduate School of Management at UCLA, professor Arthur M. Geoffrion teaches a popular course on using the Internet and commercial on-line services in business. He teaches students how to use the basic tools of the Internet—ftp, gopher, search tools, and the WWW (World Wide Web)—and almost all class time is spent "in front of the tube," learning from doing.

Geoffrion asserts that "networking power" will become a new metric of professional skill. "Knowledge of networked-



Systems analyst Garfield Williams studies financial data at a FAST workstation. The system receives real-time data showing what's happening on the market.

PHOTOS: BILL REDIC © 1995

prehension, especially with more difficult material.

While Mostow concedes these results aren't earthshaking, it's progress nevertheless. "If we can provide an environment that makes reading less frustrating and encourages them to do lots of reading, then we'll see benefits," he says.

Center for the Advancement of Applied Ethics

Does a person have a right to die? Or to have medical treatments stopped? These issues are discussed in senior researcher Robert Cavalier's courses on ethics. To bring them to life, Cavalier uses a multimedia videodisc called The Case of Dax Cowart, based on the true case of a young man burned horribly in a freak accident. Rather than undergoing painful treatments and enduring a life of physical handicaps, he asked his doctors to let him die.

The disc gives students something other than words in a textbook; it includes video clips of Cowart's treatments and interviews with the patient, his mother, and his medical team. The multimedia presentation is designed to provoke discussion and philosophical reflection on the subjects of patients' rights, medical intervention, and assisted suicide. After students decide what they would do in Cowart's case, the disc shows them what actually happened.

"The traditional classroom doesn't convey these difficult situations," Cavalier says. Seeing and hearing from the patient and his doctors gives the student more information to draw from, as well as "the duress of counteropinions." The Center plans to put this kind of courseware out on the WWW (World Wide Web) and then have other real-life cases added.

Situated Learning

Phil Miller has taken the concept of *situated cognition*, or learning while doing, and applied it to teaching computer programming. A principal lecturer in computer science, Miller says, "straight lecturing puts people to sleep." Instead, he says, you teach people by "giving them something real to do."

To teach programming to students who perhaps couldn't care less about loops and stacks, Miller develops science courses that have programming lessons built in. For example, he gives biology majors a simulation of fruit-fly embryo development. Underlying that simulation, of course, are lines of code. Students can go into the code to either make changes to the simulation or learn what factors trigger certain events. "You want to change how diffusion works?" Miller asks. "Then hop on in there and change the code."

By working with the program, students consequently learn about data structures, algorithms, and other elements of software. In a similar way, business majors could tweak a sales-tracking program written in Visual Basic, or art students could work with a program that generates paintings. "Instead of just teaching programming," Miller says, "you give students a relevant context in which to learn programming—a context that interests them."

Informedia Digital Video Library

The Informedia project, which is still in prototype form, provides access to archives of videotape. But unlike video on demand, which can search only for titles (e.g., "Computer, find *The Wizard of Oz*."), the Informedia system can search and retrieve on the basis of content (e.g., "Computer, find every clip in which there's a reference to *brain, heart,* and *courage*."). It works by recognizing speech on the audio track and constructing an index from the text.

In a demonstration of the system, Carnegie Mellon vice provost for research computing Howard Wactlar asked about traveling to Mars. The system zeroed in on one of its "books"—a PBS documentary—and brought up film clips of Arthur C. Clarke and others discussing interplanetary exploration.

The material is more complete than the documentary shown on TV. The version in this library includes outtakes, so 30 minutes of the interview with Clarke et al. is available, not just the 2 minutes that survived the final editing for the program.

In another example, Wactlar queried about parallel processing. The system tapped into a group of videotaped lectures and brought up a clip of Thinking Machines' Danny Hillis explaining the basics of parallelism.

Ultimately, Carnegie Mellon envisions distributed libraries containing video on hundreds of topics. You'll be able to dial up and have the video blasted over the phone lines. "It will promote lifelong learning at work and at home," Wactlar says.

Dennis Barker is BYTE's chief of correspondents. You can reach him on the Internet or BIX at dbarker@bix.com.

based communications and on-line resources, how to use them, and the cooperative society of the Net all [improve] the creativity, productivity, quality, and quick responsiveness of professional work," he says.

Networked applications using NetWare are widespread in colleges and training centers, says Janet Perry, manager of technology transfer partners for Novell. Among the benefits she cites are ease of distributing information and course materials and improved communications, especially between students and teachers.

At the University of Delaware in Newark, Solaris-based servers store scanned color images for art, history, and botany classes. Students say they prefer these to black-and-white reproductions in textbooks, and not only because of the better quality. They can view them at their leisure, without regard to hours, location, or other people using the slides.

When you layer collaborative software

Building the Virtual College

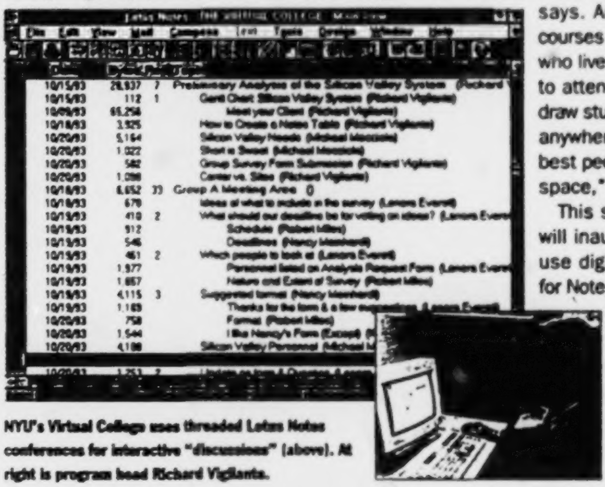
NYU uses Lotus Notes to reengineer post-graduate studies

Is it possible to create a college, a curriculum, or even a student café entirely in cyberspace? Absolutely. The School of Continuing Education at New York University (New York, NY) has done just that, through a program that builds on Windows, NetWare, Lotus Notes, ISDN, and Indeo digital video.

Begun in 1992, the NYU Virtual College offers a small number of courses taught entirely in virtual classrooms. Each student owns a Windows-capable PC and modem. Through Notes servers accessed via toll-free dial-in lines, students receive electronic "lectures" that are delivered as multimedia presentations, obtain required course readings, contribute to discussion topics, and send E-mail to one another and the instructor. Participation in the program costs about $2000 per course.

Currently, the Virtual College is used mainly for midcareer training. "We needed to get away from the model of flying people to a place, putting them up in a hotel, and all the costs and lost productivity that go with it," says Dr. Richard Vigilante, head of the program. "Not to mention the problem of compressing into days something that might be better absorbed over weeks," he adds. Scheduled classes are especially impractical for busy mid- and senior-level executives who travel a lot; the Virtual College lets them "attend" classes anytime and anywhere, within the confines of the semester.

The program has an additional attribute that bears heavily on its success: The subject matter of the courses consists of applied IS (information systems) and virtual workgroups, so students are gaining not only theoretical knowledge of the topic but also practical, hands-on experience. Completing 16 course credits earns a student an advanced professional certificate, and an additional 16 credits of traditional graduate course work is enough for a master's degree in performance and IS auditing. "The students are using the very technologies [that] they may be implementing in their companies," says Rembert Aranda, a Virtual College faculty member.


NYU's Virtual College uses threaded Lotus Notes conferences for interactive "discussions" (above). At right is program head Richard Vigilante.

Aranda says that the most surprising result of the program to date has been its effect on student participation. The amount of interaction among students, and between students and instructors, is an order of magnitude higher than that of a normal classroom, he notes. This is measured by observing how many questions students ask and the liveliness of the discussion threads. But it's possible that E-mail and BBS postings are merely filling in for the lack of face-to-face contact.

Organization:
New York University

Technologies:
Collaborative software; E-mail; digital video

Success factors:
Customized curriculum; motivated students

Effects:
Anytime/anyplace learning; high levels of interaction

Crucial Differences

Distance learning and learning on demand aren't new concepts. What makes NYU's Virtual College different from earlier, TV-based classes is its flat hierarchy, communications symmetry, and participatory nature.

Conventional televised courses, some of which offer remote students the ability to dial in for audio feedback, tend to penalize remote learners in favor of those present in the classroom. At the Virtual College, "everybody, even the teacher, attends the class on the same terms," Aranda says. And whereas night-school courses are available only to those who live nearby and have the time to attend, the Virtual College can draw students and instructors from anywhere. "You can get the very best people, regardless of time or space," Aranda says.

This spring, the Virtual College will inaugurate its first course to use digital video and new Video for Notes software from Lotus. Participating students will be given local ISDN service and loaned ISDN equipment; the video clips, compressed using Intel's Smart Video Recorder, can be viewed in real time (in quarter-screen size at 15 frames per second) or pumped across the wire for local storage and viewing.

"A lot of corporate training materials are already on video, and we wanted to tap into that," Vigilante says. However, video courses typically need reworking (e.g., the addition of hypertext links or supplementary text) to succeed as interactive tools. Doing so "makes them less lecture-like and more seminar-like," Vigilante adds.

Aranda and Vigilante acknowledge that the Virtual College works partly because the students are highly motivated. But both are convinced that it's a model with enormous potential for lifelong learning. "We had a sense that the cost of education, expressed in price/performance terms, hadn't been improving at the same rate as computers and telecommunications," Aranda says. Now that NYU has "reengineered" the classroom, he adds, "the degree of freedom is fantastic."

environments, such as Lotus Notes, on top of a network, whole new modes of communication are unleashed. Debora Cole, academic marketing manager for Lotus, says that Notes permits "an extension of classroom learning, where you can make a contribution that others see and can respond to." It also offers rich media types, security, object-link maintenance, and other capabilities not well supported on today's Internet.

One of the most promising uses of Notes is in curriculum development. "Curriculum development is not an efficient process," Cole says. "Using collaborative software lets you work with faculty members on your own campus and worldwide to design and develop [a] new curriculum." Notes is also widely used in help-desk and customer-support applications, which often feed directly into training courses for support personnel.

E-mail among students and teachers, free exchange of curricular tools and content, consultation with on-line experts, and access to remote resources are all hallmarks of what ubiquitous networking will deliver to education. Concludes Kearsley of GWU: "The whole education community is ready to jump on the Internet full blast; Mosaic was the piece needed to make it work."

I Want My MTV

Multimedia has captured the imagination of educators more than any other technology. "It is really pumping adrenaline into the education market," observes Don Rawitsch, vice president of product development and support for software maker Jostens Learning (San Diego, CA).

Multimedia, as such, encompasses a range of data types, including analog and digital video, two-dimensional and 3-D animation, audio, and even hyperlinks and digital ink. It also includes delivery media, such as CD-ROM discs and drives, graphics display hardware (e.g., compression/decompression, acceleration, and codec cards), and sound cards. Specialized hardware devices, such as DSPs (digital signal processors) for speech and signal processing, are starting to appear in desktop systems and will play an increasing role in learning systems.

According to QED, 25 percent of school software budgets in 1994 were allocated to multimedia titles. Given the enormous growth of CD-ROM-equipped PCs in homes, multimedia could soon become the key "crossover" application to link the home and school markets.

Proof of the effectiveness of multimedia isn't yet conclusive, but early studies and many anecdotes suggest its great power as a learning aid. The SPA's 1994 report on technology effectiveness cites accounts of measurable improvements from the use of animation, video, laserdiscs, CD-ROM books, and hypermedia. "Studies show that we obtain 80 percent of our knowledge visually but retain only about 11 percent of that," says Howard Wactlar, vice provost for research computing at Carnegie Mellon. "We acquire a smaller percentage through hearing," he adds, but remember more of it. He says that a combination of the two is the most effective, boosting retention rates to 50 percent.

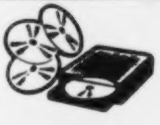
Applications for multimedia range from educational and entertainment titles, on disk or CD-ROM, from companies such as Broderbund (Novato, CA), Scholastic (New York, NY), and Davidson & Associates, to gigantic computational chemistry simulations that run on Onyx systems from Silicon Graphics (Mountain View, CA). "Multimedia lets you create a living textbook, versus a flat textbook," says Dr. Terry Crane, vice president and general manager of the education division at Apple.

One interesting multimedia application for the Mac, called CamMotion, is being developed by TERC, an R&D organization in Cambridge, Massachusetts, with funding from the National Science Foundation. It involves using visualization to learn about and analyze physical principles. A video camera lets kids capture and analyze motion on the computer. One group of students, for instance, used CamMotion to understand the difference in acceleration of a basketball when it was dropped and when it was dribbled. Textbook calculus would never have captured their interest in the same way.

Cutting Loose

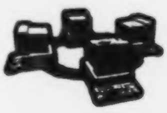
Mobility is, in a certain sense, yet another outcome of networking, but it also comes about as a result of miniaturization. Schools and training centers all over the country are experimenting with giving students notebook computers to take home with them, setting up wireless LANs for instant virtual workgroups, or establishing dial-in services that permit anytime/anywhere access to course materials and fellow students. With networks and mobile access, "time and space dependencies are eliminated," says Steve Griffin, the director of technical services at the Institute for Academic Technology.

THE EVOLVING INSTALLED BASE



- Since 1992, the number of K–12 schools with CD-ROM drives has nearly tripled, from 13 percent to 37 percent. More than 50 percent of high schools are now equipped with at least one drive, says QED (Quality Education Data).

- The number of schools with modems has jumped from 22 percent in 1992 to 33 percent today; high schools weigh in at 50 percent, says QED. But only 12 percent of classrooms have a phone line, reports the SPA (Software Publishers Association), while others claim the number is as low as 5 percent. Among on-line services, 24 percent of K–12 schools say they have access to the Internet.



- Although only a quarter of all schools and half of high schools had LANs in 1994, says QED, those figures have risen from just 14 percent and 29 percent, respectively, in 1992. The leading NOSes (network operating systems) among K–12 schools are NetWare and AppleShare, with 73 percent and 59 percent usage, respectively, according to QED. In schools with LANs, says Market Data Retrieval, 49 percent use them to connect computers in a lab, 28 percent to connect between classrooms, and 20 percent to connect between buildings.

- A 1993 study done by the National Educational Association found that 62 percent of elementary school teachers had computers in their classrooms, versus 44 percent of high-school teachers. One explanation: Children spend most of their time in one room, whereas high-schoolers move from one class to another and computers are clustered in areas such as science labs or libraries.

- According to QED, 46 percent of the installed base of computers in grades K–12 are Apple IIs, 32 percent are DOS compatibles, and 15 percent are Apple Macs. In the 1993–94 school year, QED estimates, unit purchases were 61 percent Macs, 18 percent IBM-brand PCs, and 18 percent other DOS compatibles. The SPA found that 42 percent of the school districts it surveyed are testing or implementing Windows on their DOS systems.

Distance learning, held out for years as a prime example of the potential of educational technology, benefits enormously from the combination of networking and mobile access. Instead of the conventional broadcast model of distance learning, which requires participating students to watch a live video transmission (via cable or satellite) or wait for days to receive a videotape in the mail, new schemes allow students to dial in at their convenience and partici-

Starting from Scratch

UCLA's graduate business school plans to completely reengineer its computer infrastructure

TOM R. HALFHILL

Ranked by *Business Week* as one of the top 10 business schools in America, the John E. Anderson Graduate School of Management at UCLA is on the verge of a rare opportunity to completely reengineer its computer infrastructure. In June, the Anderson School is scheduled to move into a new six-tower building that's custom-built to the school's specifications. Years of careful planning—and fund-raising—will culminate in new computer labs, classrooms, libraries, offices, conference rooms, and a centralized computing center—all tied together by a state-of-the-art "virtual network" that discards nearly 40 years' worth of legacy equipment and cabling.

UCLA's business school has had a long tradition of cutting-edge technology and business-oriented computer training. In 1957, IBM established the Western Data Processing Center at UCLA, a groundbreaking installation. The original "glass house" that enclosed the IBM mainframe still stands in the Anderson School's present-day building, and large parts of IBM's 360 operating system were written in rooms that are now occupied by faculty members and student computer labs.

As computers evolved, so did the business school. UCLA moved from punch cards to DECwriters to video terminals—and, in the 1980s, to microcomputers. In the mid-1980s, another IBM grant allowed UCLA to become one of the country's first totally networked business schools.

Additional grants from Hewlett-Packard and Apple allowed the school to set up labs with scores of PCs and Macs, all linked to an HP minicomputer running a custom E-mail system for the 1200 students, 100 faculty members, and 180 staff personnel. Today, a new HP 9000-H70 superminicomputer handles an astounding 350,000 to 500,000 E-mail messages per week, mostly internal.

Why so much E-mail? A major factor is that Anderson's MBA programs strongly emphasize team projects. In addition to the frequent break-out sessions associated with regular classes, second-year MBA candidates must complete a field-study project with a team of fellow students. "You deal with a client, you interface with them, and there's a lot of coordination that goes on between you and your teammates," explains Max Shoka, an electrical engineer and second-year MBA student. "We don't have any central office, we're doing a thousand things, and we need ways of passing information back and forth," he adds.

Anderson's current patchwork of 10 servers (variously running HP-UX, NetWare 3.12 and 4.01, AppleShare 4.0, and OS/2 1.3) and about 400 client machines is straining under the load of this traffic. Most users access the E-mail network over 9600-bps serial lines; only a minority have 10-Mbps 10Base-2 Ethernet connections.

The network is further stressed by students dialing in from the outside. About 80 percent of them have their own computers, including 420 executive MBA students who work full-time jobs and connect remotely from university-supplied PowerBook 170 and 540c notebooks. Next fall, every Anderson student will be required to own a computer; in the fall of 1996, they may be required to own a laptop.

Organization: John E. Anderson Graduate School of Management, UCLA

Technologies: Ubiquitous high-bandwidth networking; remote access

Success factors: A wealthy patron; a network built from scratch

Effects: Virtual networks; team projects

Future Vision

To cope with this wired environment and allow room for growth in the future, the new 280,000-square-foot building is a network manager's dream. The school's aggregate network bandwidth will be 30,000 to 50,000 times greater than before, and the entire network has been redesigned from scratch.

Jason Frand (above) spearheaded a technology program for UCLA's Anderson School. Cables are pulled through individual conduits for easier upgrading (inset).

PHOTOS MICHELLE M. SMITH © 1995

Every seat in every classroom, library, and office—2462 locations in all—will be wired with power outlets and 10Base-T Ethernet connections. Small break-out rooms will be wired so that teams of students can set up ad hoc networks with their laptops. Each classroom will have a computer built into the instructor's podium and a video projector suspended from the ceiling, so any screen in the room can be displayed to the whole class. New labs will be equipped with dozens of PCs, Power Macs, and multimedia gizmos, including scanners, video-capture boards, camcorders, and color printers.

Everything will be tied into a central computer room over a backbone of fiber-optic cables and ATM (Asynchronous Transfer Mode) switches. David VanMiddlesworth, the network manager, says ATM was chosen because it has great bandwidth, can handle isochronous transmission, and is relatively easy to reconfigure on the fly.

Profuse networking and a highly computer-literate student body will let the school deliver lessons that require students to browse the Internet and analyze information from diverse sources. "That's what life is going to be like for the MBAs when they leave here," says VanMiddlesworth. "We have to give them the tools to do that."

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pate in a class asynchronously. While it isn't in real time, the opportunity for feedback and participation is enhanced by rich two-way communications channels.

New York University's School of Continuing Education has pioneered a Notes-based distance learning application (see the text box "Building the Virtual College" on page 56), and others are not far behind, including California Polytechnic and the New Jersey Institute of Technology. Collin County Community College, of Plano, Texas, is exploring the idea of creating a virtual college at which its students could learn from graduate students at a university. The transport will likely be via E-mail messages over the Internet.

The Training Imperative

But "the fastest-growing segment of education is within industry," says Robert Sullivan, dean of the Graduate School of Industrial Administration at Carnegie Mellon. "Industry is faced with the question of how to keep the work force up to speed."

One answer, known as "training on demand," involves bringing information to employees at their workstations. "It's just not feasible to put employees in classrooms," says *Learning Enterprise* editor Manasco, who adds that classroom training is enormously expensive and notoriously inefficient in terms of retention and recall.

Hewlett-Packard has harnessed one such solution to cut some of its sales-training costs from $2 million to $200,000 per year. Previously, the company brought a conventional dog-and-pony show to 12 different cities, which took four to five weeks per quarter. Now, through an interactive satellite network, training sessions require just two days, and nobody has to travel. Furthermore, the message and delivery are more consistent, and there's a much shorter lag time between distribution and utilization of information.

Through the use of advanced simulators, Burlington Northern Railroad, in Fort Worth, Texas, has boosted its training productivity by 15 percent per year and improved quality, according to Edward Butt, assistant vice president of technical training. In the past, new engineers had to spend most of their training time in locomotives, which presented logistical challenges and limited the range of experiences encountered during training. Now, with images generated on Silicon Graphics workstations and a program from Hughes Electronics, engineers experience a full range of real-world scenarios, including emergencies and varying weather conditions.

Manasco, Schank, and Johansen all ar-

When Money Is Plentiful

The Peddie School pushes the envelope in secondary education

SALVATORE SALAMONE

The Peddie School, in Hightstown, New Jersey, enjoys an unusual distinction among private secondary schools: In 1993, alumnus Walter Annenberg gave it $100 million, the largest single donation ever made to a prep school. The gift launched Peddie into national prominence and afforded it the opportunity to implement an ambitious technology program. While its wealth is by no means typical, Peddie has certainly blazed a trail by demonstrating what technology can do when resources are relatively unconstrained.

Rather than simply computerizing traditional teaching methods, Peddie has used computers to change the entire educational process. Students complete their course work using E-mail, an electronic library, and unlimited Internet access, all of which can be accessed from PCs in dorm rooms or from one of 60 public PCs connected to the school's campus network. Peddie features a student-centered learning environment in which teachers are guides to information resources, rather than imparters of canned material. In fact, teachers are as likely to be other students as they are faculty members; this redefinition makes students more responsible for their own educations.

Organization: The Peddie School (Hightstown, NJ)

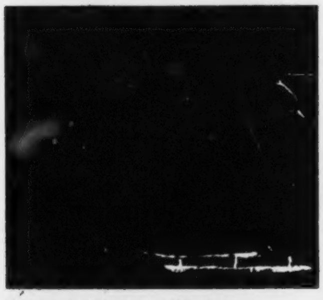
Technologies: E-mail; Internet; digital library

Success factors: A wealthy patron; new instructional models

Effects: Reduced barriers to communications; increased student enterprise

Quick Start

The process begins on a student's first day at Peddie when, as part of orientation, he or she is given an E-mail account and is taught—by other students—how to use the E-mail system. "E-mail is presented as a common thing: Here's the library, here's the cafeteria, here's your E-mail account, and here's how you use it," says Patrick Clements, a teacher and program director.


Students in Peddie's multidisciplinary Principia Project discuss their work with program director Patrick Clements.

E-mail has become a way of life for the 500 Peddie students and 70 faculty members: There are, on average, 2400 log-ins per day to the mail system. (Peddie uses Lotus cc:Mail with a gateway to the Internet.) While E-mail is certainly used for mundane chores such as distributing homework assignments, its real value lies in the way that it changes the student-teacher relationship. Outside of class, students can ask instructors questions without having to make an appointment or swing by the teacher's office. And they can ask questions when they think of them, instead of waiting until class meets the next day.

E-mail is especially useful for foreign students or students who are reluctant to speak up in class. Students who don't formulate quick questions in the classroom find they have plenty of time to pose inquiries over E-mail.

Good teachers take advantage of this. For example, Clements says he once received a message from a quiet student concerning a question about *Huckleberry Finn*; after responding with several observations, Clements asked the student the same question in class the next day and solicited his feedback. In this way, Clements was able to draw out the student; he's convinced this wouldn't have happened without E-mail.

Tools of the Trade

Peddie students are trained in Internet access and the use of an electronic library, which includes an on-line card catalog, the full text of several years' worth of the *New York Times*, citation indexes, and other resources. Students learn the basics of using these services so that other courses can draw on common skills.

One difference at Peddie is that there are no "classes of usage" for most information on the network, says Tim Corica, director of academic computing. "If something is made available on the network, it is available to everyone," he explains. This philosophy typifies a shift in the teacher-student relationship that's designed to transfer more responsibility to students. "They must now go out and find answers to questions. And, more important, ask

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gue that the traditional training department is out of step with the times. "The paradigm of training as a separate, centralized department is dead," Manasco says. "The new model is learning while working. Businesses are moving to decentralize training services and make them distributable to the desktop," he adds.

Several factors are at work here. Training departments are often among the first victims of layoffs because they're seen as overhead. Yet, at the same time, the changing nature and growing diversity of the work force require new kinds of training in cultural sensitivity, communications skills, and remediation. Employees are more geographically dispersed than in the past, and turnover is higher because companies and employees are less loyal to each other. Technology is evolving so quickly that skills require frequent refreshing.

The result is that rather than teaching employees fundamental skills (especially since workers sometimes bolt to competitors), companies are instead trying to link learning to the job itself. This can take the form of expert systems integrated into the work area or even hand-held computers connected via wireless communications to a constantly updated infobase. Steve Linsk, former product marketing manager for multimedia tools at Asymetrix (Bellevue, WA), suggests another scenario: putting self-paced employee-orientation materials on a network server instead of printing up a book.

Professor Schank is the high priest of just-in-time learning. "Anything not just-in-time is probably useless," he says. "People learn [a skill] at the moment they need to know it. It's like learning to ride a bike; if you fall off, you don't need your parents to give you a lecture about the physics of motion and gravity. You need instruction about righting yourself."

A Matter of Timing

Why is a paradigm shift in education happening just now, and not earlier? "I don't think education was really ready for this more than a year ago," concludes Donavan Merck, manager of the Educational Technology Office for the California State Department of Education. In the not-so-distant past, he says, most of the pressure to implement computers in schools came from the district level, from technology specialists who tried to push technology into the classroom. Teachers "looked at equipment such as videodiscs and software and felt that there wasn't enough there to justify the cost," Merck says.

Now, falling system prices and the wider use of networking are helping to make the shift more feasible. "The better quality of learning materials available from companies is helping a lot," Merck says. "Now it's the teachers who are going back to the district and saying they need this stuff." The shift from top-down to bottom-up adoption is making a huge difference in

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their own questions," says Corica.

In one Peddie course, students must demonstrate proficiency at using a dynamic-modeling program. In traditional teaching, the class might be given specific homework assignments that use the model, meaning that everyone does the same thing and all the answers come out the same.

Without such constraints, one Peddie student chose to model population growth as his project and built a model involving birth rates, death rates, and assumptions about current population levels. Using the Internet, the student found census data, plugged in parameters, and ran his model.

This was enough to satisfy the requirements of the course. But then he went further, locating on the Internet results from other population models to see how his simpler version compared. Contrasting the different models became part of the project. In the end, the student had learned not just about the assigned software program but also about the science of population modeling.

Peddie's Tim Corica believes the role of teachers must change to that of being a guide to resources instead of being a conveyor of facts.

Preparing for Life

Peddie's faculty members strongly believe in multidisciplinary studies to mold students who can tackle challenges in the real world. After all, business problems aren't parsed into neat little subjects where you only have to think about one thing at a time. To address this issue, last fall Peddie started a course called the Principio Project, which aims to break down traditionally fragmented approaches to learning.

Directed by Clements, the Principio Project centers around the constant use of a laptop by every student and faculty member in the program. Thirty sophomores started this year in a pilot project with an academic focus on Western culture. So far, they've struck up E-mail conversations with students living in the countries they're studying, and they're conducting research through a WWW site at the University of Granada in Spain.

If the Principio Project is as successful as other efforts at Peddie, the school will have shown yet again how computer technology can be used to change education. The best news is that not all of this technology is wildly expensive. But the cost of doing it right is a lot more than just buying the hardware.

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how willing and eager instructors are to make the leap to educational technology.

Another major factor is the rapidly evolving computer environment outside the classroom. Many parents work in companies where computer technology is prevalent and sophisticated; they're starting to ask why schools lag behind, because they want their children to be trained in essential computer and information-gathering skills. Pressure from parents is starting to force school boards to spend more on technology.

Nonetheless, there are many problems still to be solved before learning technology can be successfully applied in schools and companies. Some skeptics point out that new learning models rely too much on the presumption that students are curious and have initiative, plus the social skills and attention span required for them to cooperate and work in teams. The behavioral problems many teachers witness today and the knowledge gaps many companies are being forced to fill are evidence that more fundamental issues need to be addressed.

Schank criticizes organizations for investing too heavily in distance learning and collaboration, which he thinks miss the point of educational technology. "It leaves out the core problem, which is that people need to be able to experiment without fear of embarrassment and with experts looking over their shoulders," he says.

Another problem is that technology can widen the socioeconomic gap between information haves and have-nots. A significant shortage of powerful, easy-to-use tools for creating curricula continues to suppress both the application of educational technology and its enormous potential for the future. To succeed in the market, educational technology requires the same sort of grass-roots army of do-it-yourself programmers that drove Lotus 1-2-3 and Microsoft Visual Basic into corporations. Kearsley of GWU believes the breakthrough may be the WWW, which he likes to refer to as "the network equivalent of HyperCard."

According to Asymetrix's Linsk, 50 percent to 70 percent of people who buy multimedia authoring tools, such as ToolBook, use them to develop courseware of one sort or another. Unfortunately, the cost of doing so is significant. A 1994 study of computer-based training found that the mean number of hours required to create a single hour of courseware was 228, Linsk says. At a conservative rate of $100 per hour, that works out to more than $20,000 per hour of courseware.

APPLYING TECHNOLOGY CAN RESULT IN:

- Boosting of curiosity, creativity, and teamwork
- Changed role of the teacher
- Reemergence of the apprenticeship model
- Reduced intimidation and frustration among students
- Reduced behavioral problems and improved concentration and self image
- Access to more information (i.e., background on demand)
- Richer information environment to penetrate "media overload"
- Breaking down the walls of the classroom, integrating home, town, and world

On the other hand, that's significantly less expensive than transporting employees to a central location, putting them up in hotels, and forfeiting their lost productivity—all to stuff their heads with information they'll largely forget. "If you distribute the material, students can learn it themselves," Linsk says. "There's a measurable ROI in dollars saved, increased retention, and decreasing learning time."

FIVE GOLDEN RULES

1. Computers should be used to enhance, not replace, the teacher and supplement, not supplant, traditional teaching methods. Corollary: Computers should be used for the things they're good at, and people should be used for the things they're good at.

2. No more than 50 percent of the total information-technology budget should be spent on hardware; 30 percent should be spent on software, and at least 20 percent should be spent on support. Don't skimp; buy as much horsepower as you can afford, because it won't become obsolete as quickly.

3. Find local partners to help with purchasing, and especially with support. Some computer and software companies have adopt-a-school programs (even if the companies aren't local, employees are willing to support their alma maters). In addition, many corporations extend support to local educational institutions (in part out of enlightened self-interest, and in part because they can use the facilities after hours for their own training).

4. All computers should be networked with outside access. Don't let a renovation project at your school or company occur without taking the opportunity to rewire.

5. The best pilot classes for any new technology are those that teach teachers to use the technology upon which a class is based. Thus, it's wonderful to use a distributed Notes network to teach students about setting up and managing Notes installations or other client/server infobase products. Perhaps less appropriate: testing your new Notes-based teaching system on a course about thirteenth-century Chinese vase decoration.

Linsk and others contend that the quality of development tools has greatly improved, such that teachers with no programming knowledge can now create their own courseware. But this raises a question: Just because teachers of the previous generation knew how to write didn't mean they created all their own textbooks, so why are we to assume they will develop hypermedia software?

A report by IBM Academic Computing confirms this problem and highlights how little incentive teachers are offered for making the extra effort. Among the 1000 colleges and universities surveyed in 1993 by the University of Southern California, 86 percent had no policy of rewarding faculty for developing courseware or any royalty-sharing program for faculty-developed courseware. Sixty-five percent had no formal projects for developing instructional software at all.

Sane Solutions

The solutions to these problems will come from the public, private, and nonprofit sectors. The ISTE, for instance, has developed a set of proposed standards for institutions seeking accreditation to teach educational technology. Now approved by the National Center for Accreditation of Teacher Education, the standards dictate minimum equipment and course offerings. Executive officer Dave Moursund says that the ISTE is also working on a set of guidelines for the use of technology in K-12 education, including basic skills, use of technology within a subject matter, baseline equipment standards, and evaluation and assessment methods. Pilot studies are under way, although a draft of these specifications may not be ready for several years.

In the public sphere, legislation and changes in regulations will be needed to boost educational technology. Educom is spearheading an effort called the National Learning Infrastructure Initiative—a conscious play on the official name of the data highway, the Na-

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tional Information Infrastructure. The former aims to ensure that the latter includes a significant major educational component.

To penetrate all schools—not just the ones with technology champions—technology vendors need changes to be made in state purchase policies so no one has to sneak in software under textbook budgets. And somebody, probably the federal government, needs to pick up the tab for the estimated $8 billion to $9 billion cost to connect every school in America to the data highway.

Dr. Linda Roberts, special advisor to the U.S. secretary of education and director of the Office of Educational Technology, points out that she is the first such advisor the Department of Education has ever had. The department is pursuing a variety of programs, including challenge grants for developing compelling educational technology and direct grants to the states for technology planning. The good news, she points out, is that even with today's minuscule technology budgets, there's enough revenue potential to support good products from private industry.

"The bad news is that education as a share of the whole market is still pretty small," she adds. "So, we need some stimulus from the public sector to push for the advances that can make a real difference." One such program, which is a classic case of innovative public/private partnership, is Vital Links, a joint development of the Los Angeles County Office of Education, Davidson & Associates, and publisher Addison-Wesley (Reading, MA). The package will consist of a year-long U.S. history course for children who have limited proficiency in English.

To help defray costs and ensure a market for the product, the state education departments of California, Florida, and Texas are each kicking in $400,000 of development funding in exchange for a royalty stake. California has also funded several development projects by San Ramon–based educational software supplier Decision Development.

The ultimate boost for educational technology may come from the data highway. "Everybody is excited by the idea of kids using the same materials at home and at school," notes Don Rawitsch of Jostens Learning. He speculates that Jostens "might team up with somebody like a cable [company] or a telco" to deliver educational materials directly into the home.

Enthusiasm for educational technology, always high, has reached new levels because of the growing use of home and business multimedia, the high profile of the Internet and data superhighway, and the continuing pressure to work and learn more efficiently. Nirvana isn't here yet, and substantial hurdles remain, but there is a growing commitment from teachers, trainers, managers, and vendors to make better use of the technology that's already here. "We don't know yet whether everybody learns better with this stuff," says Dr. Miriam Masullo, a researcher with IBM in Hawthorne, New York. "But," she adds emphatically, "we can't find out until we try it." ■

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Additional reporting was provided by BYTE chief of correspondents Dennis Barker, senior editors Ed DeJesus and Tom R. Halfhill, and news editor Salvatore Salamone.

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Answers to Commonly-Asked Primary and Secondary School Internet User Questions
FYI, RFC #1578-Schools and Internet
–Excerpts–

by Jennifer Sellers
NASA NREN

Note: These are only selected highlights from the article. The complete document can be accessed at http://chs.cusd.claremont.edu/www/people/rmuir/rfc1578.html

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Status of this Memo

This memo provides information for the Internet community. This memo does not specify an Internet standard of any kind. Distribution of this memo is unlimited. Editing into HTML by rmuir@chs.cusd.claremont.edu.

Abstract

The goal of this FYI RFC, produced by the Internet School Networking (ISN) group in the User Services Area of the Internet Engineering Task Force (IETF), is to document the questions most commonly asked about the Internet by those in the primary and secondary school community, and to provide pointers to sources which answer those questions. It is directed at educators, school media specialists, and school administrators who are recently connected to the Internet, who are accessing the Internet via dial-up or another means which is not a direct connection, or who are considering an Internet connection as a resource for their schools.

1. Introduction

The elementary and secondary school community of teachers, media specialists, administrators, and students is a growing population on the Internet. In general, this group of users approaches the Internet with less experience in data network technology and fewer technical and user support resources than other Internet user groups. Many of their questions are related to the special needs of the community, while others are shared by any new user. This document attempts first to define the most frequently asked questions related to the use of the Internet in pre-university education and then to provide not only answers but also pointers to further information. It is important to remember that the Internet is a volatile and changing virtual environment. I have tried to include only the most stable of network services when listing resources and groups for you to contact, which is a good solution to the problem of changing offerings on the Internet, but by no means a fool-proof one. This constant change also means that there is a lot out there that you will discover as you begin to explore on your own.

3.2 What are the benefits of using the Internet in the classroom?

The Internet expands classroom resources dramatically by making many resources from all over the world available to students, teachers, and media specialists, including original source materials. It brings information, data, images, and even computer software into the classroom from places otherwise impossible to reach, and it does this almost instantly. Access to these resources can yield individual and group projects, collaboration, curriculum materials, and idea sharing not found in schools without Internet access.

Internet access also makes contact with people all over the world possible, bringing into the classroom experts in every content area, new and old friends, and colleagues in education. With access to the Internet, your site can become a valuable source of information as well. Consider the expertise in your school which could be shared with others around the world.

The isolation inherent in the teaching profession is well-known among educators. By having access to colleagues in other parts of the world, as well as to those who work outside of classrooms, educators able to reach the Internet are not as isolated.

A hands-on classroom tool, the use of networks can be a motivator for students in and of itself, and their use encourages the kind of independence and autonomy that many educators agree is important for students to achieve in their learning process. Because class, race, ability, and disability are removed as factors in communication while using the Internet, it is a natural tool for addressing the needs of all students; exactly how this is done will vary from district to district as schools empower individual teachers and students.

School reform, which is much on the minds of many educators today, can be supported by the use of the Internet as one of many educational tools.

3.3 How can educators incorporate this resource into their busy schedules?

Most educators learn about the Internet during the time they use to learn about any new teaching tool or resource. Realistically, of course, this means they "steal" time at lunch, on week-ends, and before and after school to explore resources and pursue relationships via the Internet. Those who do so feel that it is well worth the rich rewards. It's important that computers used to access the Internet are readily available and not so far away physically as to make using the resource impossible for educators and others.

Many features of the Internet, such as the availability of online library catalogs and information articles, will actually end up saving considerable time once an instructor learns to use them, and there are new tools being developed all the time to make Internet resources more easily accessible.

As the value of the Internet as an educational resource becomes more evident, school systems will need to look toward building the time to use it into educators' schedules.

4. Questions about School Support for an Internet Connection

4.1 Where does my school get the money for connecting to the Internet?

Although school budgets are impossibly tight in most cases, the cost of an Internet connection can be squeezed from the budget when its value becomes apparent. Costs for a low-end connection can be quite reasonable. (See the next question.)

The challenge facing those advocating an Internet connection sometimes has less to do with the actual cost than it has with the difficulty of convincing administrators to spend money on an unfamiliar resource.

In order to move the Internet connection closer to the top of your school's priority list, consider at least two possibilities. First, your school may be in the process of reform, as are many schools. Because use of the Internet shifts focus away from a teacher-as-expert model and toward one of shared responsibility for learning, it can be a vital part of school reform. Much of school reform attempts to move away from teacher isolation and toward teacher collaboration, away from learning in a school-only context and toward learning in a life context, away from an emphasis on knowing and toward an emphasis on learning, away from a focus on content and toward a focus on concepts [3]. The Internet can play an integral part in helping to achieve these shifts.

Second, to demonstrate the value of a connection, actual Internet access is more useful than words. While this may sound like a chicken-and-egg situation (I have to have Internet access to get Internet access), some organizations will provide guest accounts on an Internet-connected computer for people in schools who are trying to convince others of the value of an Internet connection.

Contact local colleges, universities, technology companies, service providers, community networks, and government agencies for both guest accounts and funding ideas. For alternatives to your own school's budget or for supplements to it, look for funding in federal, state, and district budgets as well as from private grants. Work with equipment vendors to provide the hardware needed at low or no cost to your school, and consider forming a School/Community Technology Committee, or a joint School District/School/Community Technology Committee.

The Educational Resources Information Center (ERIC) has information on grants and funding. Ask for the AskERIC InfoGuide called "Grants and Funding Sources". Two network services, one maintained by the United States Department of Education's Office of Educational Research and Improvement (OERI) and one maintained by the US National Science Foundation, also have information about grants and funding. Grants can be a way for you to acquire the initial money to demonstrate the value of telecommunications in the classroom, and since these monies are often awarded on a short-term basis, should probably be looked at as temporary means of funding your activities.

4.2 How much does it cost to connect to the Internet, and what kind of equipment (hardware, software, etc.) does my school need in order to support an Internet connection?

The cost of an Internet connection varies tremendously with the location of your site and the kind of connection that is appropriate to your needs. In order to determine the cost to your school, you will need to answer a number of questions. For help in learning what the questions are and getting answers to them, begin asking at local colleges, universities, technology companies, government agencies, community networks (often called "freenets"), local electronic bulletin board systems (BBS), network access providers, or technology consultants.

To give you an idea of possible equipment needs, here are three sample scenarios, based on possible solutions found in the United States. Keep in mind that these are very general examples and that there are many solutions at each level. See also the answer to Question 5.5.

- ☐ Low-end: You could subscribe to some kind of Internet dial-up service. This may be provided by a vendor at a cost, by a local university gratis, or as a part of a public access service like a community network. You will need a computer which allows terminal emulation, terminal emulation software, and a modem which is compatible with your dial-up service. The approximate cost, not including the PC or the cost of the phone call, is US $100 to US $800 plus a monthly fee of approximately US $30.

- ☐ Mid-range: You could subscribe to a dial-up service that provides Serial Line Internet Protocol (SLIP) or Point to Point Protocol (PPP), allowing your computer, in effect, to become a host on the Internet. You will need a computer with SLIP or PPP software, telecommunications applications software (to allow you to use telnet and FTP - File Transfer Protocol), and a modem which is compatible with your dial-up service. The approximate cost, not including the PC or the cost of the phone call, is US $100 to US $800 plus a monthly fee of approximately US $60.

- ☐ High-end: Your school or department could subscribe to a service that provides a full Internet connection to the school or department's local area network. This allows all the computers on the local area network access to the Internet. You will need a router and a connection to a network access provider's router. Typically, the connection is a leased line with a CSU/DSU (Channel Service Unit/Data Service Unit). A leased line is a permanent high-speed telephone connection between two points; this allows you to have a high quality permanent Internet connection at all times. A local area network, which may consist only of the router and a PC, Macintosh, or other computer system, is also needed, and your computer(s) will need some special software: a TCP/IP (Transmission Control Protocol/Internet Protocol) stack, as well as TCP/IP based communications software such as Telnet and FTP. The approximate cost, not including the computers, is US $2,000 to US $3,000 plus a monthly fee of at least US $200.

4.3 What is required in terms of personnel to support an Internet connection? (Will it require extra staff, training, more time of teachers and librarians?)

Any plan for implementing technology in schools must consider staff development. Training is often the most neglected aspect of a technology plan, and a lack of training can lead to failure of the plan. In the case of the Internet, all users will need some kind of training, whether they are teachers, librarians, students, administrators, or people fulfilling other roles in the school.

The train-the-trainer model, in which a group of people are trained in a subject or tool and each individual in turn trains other groups, is a good model for Internet training. A small group of motivated teachers can be provided with training and can then educate their colleagues. One advantage is that the initial group is able to target the specific needs of the other teachers in the school.

Depending on the hardware involved, there may be a need for technical support. Finding this kind of support, which schools will certainly need because it is not usually in place, may be tricky. Some districts are beginning to provide it at the district level. Some schools are able to use volunteers from business, industry, or government agencies. Much of this type of support can be done over the network itself, which makes it possible for someone located off-site to maintain the equipment with only occasional trips to the school. Additionally, vendors often provide some support, perhaps a help desk for basic questions.

4.4 How do I convince the people who do the purchasing in our school system to spend money on this?

Most people become convinced with exposure. One excited individual in the school who is able to show proof of concept by starting a pilot program can be the catalyst for a school or an entire district. If you can get an Internet account (as suggested above) and use it for instruction in your classroom, you can make presentations at faculty, school/community, and school board meetings.

The National Center for Education Statistics in the Office of Educational Research and Improvement at the United States Department of Education has released a 17-minute video targeted at school administrators entitled "Experience the Power: Network Technology for Education". It uses interview clips of students, teachers, and policy makers in the United States to educate about what the Internet is and to encourage support for the use of telecommunications in primary and secondary schools. The NASA NREN (US National Aeronautics and Space Administration National Research and Education Network) K-12 Initiative has produced an 11-minute video describing the benefits to schools in using the Internet. The video is entitled, "Global Quest: The Internet in the Classroom", and it tells the story through interview clips with students and teachers who have experienced the power of computer networking.

4.5 Where do I go for technical support and training?

Much technical support and training can be found by using the Internet itself. You can send questions to people in the know and join discussion lists and news groups that discuss and answer questions about support and training.

Network News, or Usenet News, is a world-wide bulletin board system with discussion groups on various topics, including computer science, general science, social and cultural themes, recreational interests, etc. By sending questions to an appropriate news group you can receive answers from people experienced with your particular problem. Specific news groups to look for are those beginning with *comp* for 'computer,' and followed by the type of operating system, hardware, or software you have a question about. For example, *comp.os.unix* or *comp.os.msdos.apps*. To understand the culture and etiquette of Usenet News, read the group *news.announce.newusers*.

Your local community may also have resources that you can tap. These are again colleges and universities, businesses, computer clubs and user groups, technology consultants, and government agencies.

Your network access provider may offer training and support for technical issues, and other groups also offer formal classes and seminars. For those schools who have designated technical people, they are good candidates for classes and seminars.

There are some documents for further reading and exploration that you may want to peruse. For new books, check your local library, bookstore, or booksellers' catalogs.

5.Questions about Implementation and Technical Options

5.1 How do I learn about options for getting my school connected?

You can sometimes locate a person enthusiastic about the idea of using networks in schools and willing to help you, who works as an independent consultant, in a local college or university, in a technology company, for a network access provider, at a community network, or in a government agency.

There are also a number of books about the Internet and how to get connected to it. Check libraries, bookstores, and booksellers' catalogs.

5.2 How many of our computers should we put on the Internet?

You will probably want to make Internet access possible for as many of your school's computers as possible. If you are using a dial-up service, you may want a number of shared accounts throughout the school. If your school has a Local Area Network (LAN) with several computers on it, one dedicated Internet connection should be able to serve the whole school.

If you are going to connect a lot of computers to the network, you will need to make sure your line speed is adequate. Most dial-up systems available today support speeds up to 14.4 Kbs (kilobits per second), which is adequate for no more than a couple of network users, depending upon the network utilities (FTP, etc.) they are using. If you are planning to connect a large number of users, you should probably consider a dedicated line of 56 Kbs or higher.

5.3 Should we set up a telecommunications lab or put networked computers in each classroom?

A computer lab is an easier maintenance set-up for the person in charge of keeping the equipment running and allows each individual (or pair) in an entire class to be using a computer at the same time; a computer located in the classroom is more convenient for both the teacher and the class. If you choose the lab option, you will probably want to get a commitment from specific teachers or media specialists to use the lab in the course of their teaching. You might also consider the other labs located throughout your school. For example, if you have a science or language lab, it may be the best place for your school to begin to use the Internet. And finally, remember that the library is a natural place for people to access network resources!

Networking all computers campus-wide can be expensive. You will need to consider the options--dial-up access, a dedicated line, or some other possibility--and weigh them against your school's needs and priorities. You may want to investigate having one lab, the library, and a few classrooms with modem access, assuming phone lines are available. As use of the Internet catches on, it will be more effective to create a campus-wide local area network that is routed to the Internet through a dedicated line than to keep adding modems in classrooms.

5.4 Can people get on the Internet from home?

This depends on your network access provider. It is certainly a possibility and is probably desirable for the educators at your school if they happen to have the necessary equipment at home. You will need to discuss whether you want to make this option available to students, even if it is possible technically. This is best discussed with the community your school serves in a public forum such as a school/community meeting. At issue is the shared responsibility of educators and parents to monitor student Internet use.

6. Questions About Security and Ethics

6.1 Who should have access in the school, the teachers or the students?

Clearly the answer is that all educators, including administrators and media specialists or librarians, AND students should have access to the Internet. There's no reason why support staff should not also have access. In elementary schools, access for students may be more supervised than in the upper grades.

6.2 I've heard that there are files on the Internet that parents would not like their children to get. How can students be kept from accessing this objectionable material?

If your school has a direct Internet connection, and often even if it doesn't, it is not possible to use a technical solution to prevent students from accessing objectionable material. Everyone on the network, including students, is able to download files from public electronic repositories, some of which contain materials that just about anyone would consider objectionable for school-age children. The store-and-forward scenario described in Question 5.5 is one solution to filtering the information to which students have access, but if students are allowed to use email then it is possible for someone to send them objectionable material.

For this reason, it is important that schools develop clear policies to guide students' use of the Internet and establish rules, and consequences for breaking them, that govern behavior on the Internet. Additionally, schools should consider integrating issues around technology and ethics into the curriculum [4].

Another possibility is to control the times and opportunities that students have to access the Internet, and only allow access under supervision. This is a less desirable option than teaching the ethics of Internet access as a matter of course, but may be used in combination with other methods to ensure the integrity of the school, its students, and its educators.

In any case, schools need to exercise reasonable oversight while realizing that it is almost impossible to absolutely guarantee that students will not be able to access objectionable material.

6.4 How do we keep viruses from attacking all our computers if we get connected to the Internet?

If you use the Internet to exchange data (such as text or pictures), virus infection is generally not a problem. The real concern is when you download software programs and run them on your own computer. Any program you download over the network and run could have a virus. For that matter, any program, whether on tape or a disk, even commercial software still in its original packaging, might possibly have a virus. For this reason, all computers should have virus protection software running on them.

Virus checking software is available free over the Internet via Anonymous FTP from the Computer Emergency Response Team (CERT), which is run by the US National Institute for Standards and Technology (NIST). The Anonymous FTP host computer is ftp.cert.org. Your hardware or software vendor, your network access provider, your technical support resources, or your colleagues on network mailing lists should be able to provide more specific information applicable to your site.

To help reduce the risk of downloading a virus with your program, try to use trusted sources. Ask someone you know, or send the question to a mailing list or news group to find the most reliable sites for software access.

6.5 What are the rules for using the Internet?

When your Internet connection is established, your access provider should acquaint you with its Acceptable Use Policy (AUP). This policy explains the acceptable and non-acceptable uses for your connection. For example, it is in all cases unacceptable to use the network for illegal purposes. It may, in some cases, be unacceptable to use the network for commercial purposes. If such a policy is not mentioned, ask for it. All users are expected to know what the acceptable and unacceptable uses of their network are. Remember that it is essential to establish a school-wide policy in addition to the provider's AUP.

7.Questions about Educational Projects

7.3 What are some examples of how the Internet is being used in classrooms now?

Projects which use the Internet sometimes request sites from all over the world to contribute data from the local area, then compile that data for use by all. Weather patterns, pollutants in water or air, and Monarch butterfly migration are some of the data that have been collected over the Internet. In Appendix A, you will find several examples from the Kidsphere electronic mailing list, each from a different content area and representing different ways of using the Internet.

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[1] Malkin, G., and A. Marine, "FYI on Questions and Answers: Answers to Commonly Asked 'New Internet User' Questions", FYI 4, RFC 1325, Xylogics, SRI, May 1992.

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[3] "Restructuring Schools: A Systematic View" in Action Line, the newsletter of the Maryland State Teachers Association, a National Education Association Affiliate. R. Kuhn, Editor. No. 93-6. June, 1993.

[4] Sivin, J. P. and E. R. Bialo (1992) "Ethical Uses of Information Technologies in Education." Washington, DC: U.S. Department of Justice, Office of Justice Programs, National Institute of Justice.

[5] Hoffman, E. and L. Jackson, "Introducing the Internet--A Short Bibliography of Introductory Internetworking Reading for the Network Novice", FYI 19, RFC 1463, Merit Network, Inc., NASA, May 1993.

APPENDIX A: EXAMPLES OF PROJECTS USING THE INTERNET

The following examples of projects using the Internet appeared on the Kidsphere electronic mailing list during the 1992-93 school year. The messages have been edited in the interest of space and because many of the details about how to participate are dated, but the information presented can give you a feel for the types and range of projects that happen today.

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Example One, "Middle School Math Project"
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This is the official invitation to participate in "Puzzle Now!". "Puzzle Now!" is an interdisciplinary project using educational technology as a tool to integrate the curriculum. "Puzzle Now!" provides teams of mathematics and language arts teachers and students with thematic puzzle problems via VA.PEN.

PROJECT : Puzzle Now!

SUBJECT AREA : Mathematics/Language Arts

GRADE LEVEL: 6 - 8

DURATION: This project will consist of eight one-week cycles.

PROJECT GOALS : -to increase student motivation for math problem solving;

-to emphasize the importance of addressing problems in a clear, concise, and logical manner;

-to provide students with opportunities for developing skills in written expression;

-to familiarize students with computer and modem as tools for problem solving projects.

PROJECT DESCRIPTION:
The puzzles presented in this project are no mere entertainment. These puzzles will help the student reason logically and develop thinking skills, and will assist in the understanding of many practical disciplines, such as geometry.

IT IS VERY IMPORTANT to remember that getting the correct answer isn't as important as figuring out how to find it.

DO THE SOLUTIONS HAVE TO BE SUBMITTED IN A PARTICULAR FASHION? Yes, the solution format requires that the group/team/individual first 1) restate the puzzle/problem; 2) explain the strategy, or strategies used in finding the answer; 3) state the answer.
Your team/class may turn in only one solution. That means you must work together to develop one solution to be examined by the "Puzzlemeister".

==

Example Two, "Poetry Contest, Grades 9-12"

==

National Public Telecomputing Network
--
Academy One Project Announcement
FIRST ANNUAL INTERNET POETRY CONTEST FOR SECONDARY STUDENTS GRADES 9-12

FEATURED FORM: THE SONNET

First Place Award: $50.00

Second Place Award: $25.00

Honorable Mentions: $10.00

The first annual Internet Poetry Contest invites entries from students in grades 9-12 for original sonnets written within the last 3 years. The purpose of the contest is to encourage young creative writers to practice the discipline needed to write in a particular poetic form, in this case, the sonnet form. (The sonnet is defined and examples are given below.) Sonnets may be submitted in any recognized sonnet form including Petrarchan, Shakespearean, Miltonic, or Spenserian.

Students submitting entries must include a form (given below) certifying that each sonnet entered in the contest is original and written within the last 3 years. The deadline for mailing entries is April 30, 1993. Winners will be notified individually and winning entries will also be announced via Academy I on the Internet.

Judges for the contest are current or retired English instructors throughout the United States.

Example Three, "Tracking Monarch Butterflies"

Our school has begun a study of monarchs using Nova's Animal Pathfinders. After working through these lessons, which will give us the necessary background information, we will design the format for collecting the data on sighting monarchs. We will send information on the format to any school who wishes to participate in the project. Our fifth grade students will begin this project and we hope that students from kindergarten through twelfth grade will get involved. We hope that schools from south to north along the migratory flyways will be interested in joining and collecting data about first sightings and population counts. We still have not found the lepidopterists who did the initial research but will keep looking. Hope to hear from you soon.

Example Four, "Simulated Space Mission"

National Public Telecomputing Network
--
Academy One Program Announcement

SPECIAL EVENT: NESPUT 24-HOUR CENTENNIAL SPACE SHUTTLE SIMULATED MISSION ON APRIL 27, 199

SCHOOLS, TEACHERS, STUDENTS, SPACE ENTHUSIASTS:

The April 27 simulated and telecommunicated space shuttle mission is a mostly real-time 24 hour mission involving numerous activities in space. Your school could be involved for an entire 24 hour period or for a much lesser amount of time (say just your school day or even a few hours). During that 24 hour period, schools will be linked to share information via telecommunications and a variety of activities will be going on via telecommunications and in the classroom--most of them created by the schools and students involved. The space shuttle Centennial at University School in Shaker Heights, Ohio, a real and permanent simulator, will act as itself and use its mission control area as Houston. Reports on the progress of our real student astronauts will be posted on the listserv and via the menus on NPTN affiliate systems carrying Academy One. Your school can act as any one of the following:

A second American shuttle.
A second Russian shuttle.
A weather reporting station for your area.
One of NASA's alternate landing sites.
A science station posing questions and problems for all astronauts in simulated space.
An information station, posting interesting information of interest about the space shuttle and the space program.
A graphics station, sending GIF files to other schools (especially good if you have a scanner for your computer).
Any other type of space related station or activity you can imagine.

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==================================================
Example Five, "Equinox Experiment and Calculation"
==================================================
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ATTENTION - MARCH 20, 1993 IS THE EQUINOX

A WORLDWIDE SCIENCE AND MATH EXPERIMENT

ERATOSTHENES EXPERIMENT

Eratosthenes, a Greek geographer (about 276 to 194 B.C.), made a surprisingly accurate estimate of the earth's circumference. In the great library in Alexandria he read that a deep vertical well near Syene, in southern Egypt, was entirely lit up by the sun at noon once a year. Eratosthenes reasoned that at this time the sun must be directly overhead, with its rays shining directly into the well. In Alexandria, almost due north of Syene, he knew that the sun was not directly overhead at noon on the same day because a vertical object cast a shadow. Eratosthenes could now measure the circumference of the earth (sorry, Columbus) by making two assumptions - that the earth is round and that the sun's rays are essentially parallel. He set up a vertical post at Alexandria and measured the angle of its shadow when the well at Syene was completely sunlit. Eratosthenes knew from geometry that the size of the measured angle equaled the size of the angle at the earth's center between Syene and Alexandria. Knowing also that the arc of an angle this size was 1/50 of a circle, and that the distance between Syene and Alexandria was 5000 stadia, he multiplied 5000 by 50 to find the earth's circumference. His result, 250,000 stadia (about 46,250 km) is quite close to modern measurements. Investigating the Earth, AGI, 1970, Chapter 3, p. 66.

The formula Eratosthenes used is:

```
  DA  d=distance between Syene and Alexandria
_____  =  _____A= 360 degrees assumption of round earth
a=shadow angle of vertical stick
da  D=to be determined (circumference)
```

Are you interested in participating?

All you need to do is place a vertical stick (shaft) into the ground at your school and when the sun reaches its highest vertical assent for the day (solar noon), measure the angle of the shadow of the stick.

```
  -\
  - \
stick ->  -  \
 - a \ a=shadow angle
 - \
 -  \
ground__________________-_____\_____________________________
```

By doing this experiment on the equinox, we all know that the vertical rays of the sun are directly over the equator, like the well at Syene. Using a globe or an atlas, the distance between your location and the equator can be determined and the circumference can be calculated.

****

But how about sharing your shadow angle measurement with others around the real globe?

****

Send your measurement of the shadow angle____________degrees

Send your location city ______________________________________

Send your location country ___________________________________

Send your latitude ____

Send your longitude ____

We will compile all the data and send you a copy to use in your classroom to compare the various locations and angles.

If you're interested, send us your data. We will compile and return it to you.

=====================================

Example Six, "Famous Black Americans"

=====================================

Project Name: Who Am I?: Famous Black Americans

Subject Area: Social Studies, Research Skills

Grade Level: Grades 4-12

Project Description: The goal of this project is to assist students in increasing their knowledge of American black history. Each week, on Monday Morning, a set of three or four clues will be sent to your account. The same will occur on Tuesday, Wednesday, and Thursday mornings. At any time, through the end of the day on Friday, your students may send their answer (the name of the famous American identified by the clues) to the following online address:

whoami@radford.vak12ed.edu

A class should send only one answer each week. If two are sent, the sponsors will assume that the first of the answers is the one intended to be submitted.

The sponsor will collect all answers, compile a listing of classes who send the correct answers, and will forward this list to all participants via email by early on the following Monday morning. On that morning, in addition, the sponsor will send all classes a new problem.

This project lasts five weeks, with clues each week being given for a different famous person in American history.

Project Length: Five Weeks

Awards: Every Monday morning, participating classes will receive an online message from the sponsor congratulating those who have sent correct answers during the previous week. At the end of the five weeks, attractive certificates will be awarded to all participating classes (sent by way of the Postal Service). In addition, classes which have participated in each of the five weeks will receive a separate style of certificate for their school or class.

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Case Studies of K-12 Educators' Use of the Internet: Exploring the Relationship between Metaphor and Practice

Margaret Honey & Katherine McMillan .
Center for Children and Technology
Education Development Center

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> To appreciate what the Internet has to offer, imagine discovering a whole system of highways and high-speed connectors that cut hours off your commuting time...This is a new dimension - an electronic, virtual world where time and space have almost no meaning. (From Tracy LaQuey, *Internet Companion*)

> The Internet is like an ocean. It is huge. No one owns it. It is filled with valuable resources. You could swim freely...Find wonderful islands...Become stranded...or get eaten by sharks! ! ! Fortunately, you can rescue yourself with Internet navigation tools. (From the *Merit Cruise of the Internet*)

Introduction

The Internet is in the midst of a growth spurt, and the makeup of the community of Internet users is fundamentally changing (LaQuey & Ryder,1992). The Internet is expanding from its roots as the almost exclusive domain of research scientists, technology development researchers, hackers, and international academics into serving as a resource for a far broader range of people, including students, educators. activists--potentially, just about everyone.

Making the Internet a viable resource for the K-12 community is particularly important, because it offers access to a wealth of resources that chronically have been in short supply for K-12 educators. Increasingly, the Internet is being used to overcome a number of obstacles that beset the working lives of teachers. Teachers' working days are structured and highly scheduled, leaving little or no time for non-teaching or non-administrative tasks, and few if any opportunities to attend meetings or classes on a regular basis. In addition, teachers have limited opportunities to interact in an ongoing collaborative fashion with their colleagues in other schools, whose different experiences and perspectives can add valuable new dimensions to problem-solving. Telecommunication tools can provide teachers with access to a wealth of information, ranging from scientific studies to reports on educational research to curriculum resources and activities (Katz, McSwiney & Stroud, 1987; Katz, Inghilleri, McSwiney, Sayers, & Stroud, 1989; Ruopp, Gal, Drayton & Pfister, 1993; Watts, 1992).. The proliferation of education related newsgroups and listserves are demonstrating the technology's potential for building and sustaining professional development communities for educators.

In addition, there is widespread agreement that telecommunications tools can enhance the range and scope of what students learn in the classroom (Brienne and Goldman, 1988; Cohen and Reil, 1986; Levin and Cohen, 1985; Newman, et. al, 1988; Reil, 1985; Reil and Levin, 1990; Ruopp, 1993). With the aid of creative teachers, students are using a range of telecommunications environments to gather and exchange scientific data, to carry out creative writing projects, and to exchange cultural and social information (Foster, Julyan and Mokros, 1988; Honey & Henriquez, 1993; Riel, 1987; Rogers, 1992). In the last five years, the use of telecommunications in the classroom has moved beyond the research and development phase and become a wide-spread component of numerous technology integration efforts. Providing educators with access to the Internet is currently being discussed as an essential component of the educational reform agenda (Hunter, 1992; Lavin & Phillepo, 1990, NII, 1993).

Despite its promise, widespread use of the Internet has not yet become a reality for the vast majority of K-12 educators. Results of a national survey of K-12 educators' use of telecommunications for student learning and professional development suggest that, even among a technologically sophisticated group of practitioners, Internet access was limited and use of tools, other than electronic mail, was rare. This research aroused our curiosity about those few educators who were actively using the Internet. In particular, we were interested in exploring two issues: the range of circumstances in which educators are using the Internet, and the ways in which these different environments influence and shape their interpretations of the Internet as a resource for K-12 education.

As the quotes at the opening of this paper demonstrate, very different images and representations of the Internet exist. The Internet as "superhighway" -- by far the most commonly used metaphor -- calls forth a trail of associations. Superhighways imply fast, efficient travel; well-mapped roadways that are easy to enter and exit; and many thousands of individuals effortlessly zipping from one point to another. In contrast, the Internet is sometimes described as an ocean. Oceans call forth a very different set of associations: exploration, discovery, murkiness, mystery, uncharted territory, and perhaps the threat of drowning. As the network of networks, the Internet does not lend itself to literal representation, it is abstract, complex, and hard to pin down. Consequently, metaphors play an important role in structuring our relationship to and experience of the Internet, and influence the ways in which we are invited to engage with its resources.

In this research we investigate the kinds of representations and associations that educators are building of the Internet and the ways in which these representations vary depending upon the circumstances of use. We set out to explore how such factors as prior experience with technology and teaching, availability of training and/or collegial support, administrative commitment, as well as the type of Internet connection and the availability of navigation tools might affect educators experiences and attitudes toward the viability of the Internet as a K-12 resource.

Developing the Sample

We contacted a subset of those respondents from the CTE national telecommunications survey who reported that they used the Internet for more than just electronic mail. Because we were interested in examining a range of practices and circumstances of Internet use, we contacted classroom teachers, technology specialists, and district coordinators/supervisors, who represented different grade levels in different geographic regions. Educators were contacted electronically, over the Internet, as well as through the CTE newsletter and the Cleveland FreeNet. All responses were voluntary.

This study is based on the responses of 18 educators, 9 women and 9 men, who have spent an average of 19 years working as educators. Nine of the respondents were classroom teachers, four were district technology supervisors/coordinators, three were technology specialists at the classroom or school level, and two were librarians/media specialists. Although we aimed to represent all regions of the country in our sample, in the end we did not have any representatives from California or the Pacific Northwest, but other regions of the country were well represented. The breakdown was as follows: five from the Midwest, four from the Northeast, four from the South, and two each from the Mid-Atlantic and Southwest states.

The Research Design

All but two of the eighteen interviews were conducted over the Internet. The remaining two were conducted over the phone. After an initial contact, participants were sent a open-ended questionnaire that covered the following topics:

- *Internet Use:* How long have you been using the Internet? For professional or for student use? What resources, what tools do you use?

- *Involvement:* How are you connected? How did you get started? Are you in a collaborative relationship with another institution?

- *Learning:* How did you learn? What were the obstacles? What was your original vision and how did it change? What was your previous experience with technology?

- *Use in schools:* How does the Internet fit into your school day? Who else in your school uses it? Do you act as a resource person for other users? How is access paid for? Is your administration supportive?

- *Future:* What would you do to improve the Internet for educators?

- *Your background:* How long have you been teaching? What is your primary job now?

Analysis

After reading through all of the replies it became clear that the respondents were offering a range of interpretations of their experience with the Internet in response to the question: "How did your initial vision or understanding of the Internet mesh with the realities of Internet use? Is your vision supported, modified, or drastically revised?" Based on their replies, we were able to group respondents according to their statements about the potential benefits and difficulties of using the Internet as a K-12 resource. We then investigated whether these differences appeared to be related to the following set of contextual variables: number of years working as an educator; number of years using computers for instructional purposes; number of years using the Internet; institutional support; collegial atmosphere; and type and amount of training about the Internet. Based on this analysis, respondents fell into one of four groups.

Findings

Enthusiastic Beginners

> I didn't have a clue as to what the Internet was before I had my introduction.... I would hate to give it up now!
>
> I did think that I would be able to use it in the classroom, but I didn't realize how much. I didn't realize how much the Internet can be utilized in a first grade room!
>
> I have just experimented with the talk and chat modes and have to say that way of 'talking' produces very strange (even profound) feelings in me.

The Enthusiastic Beginners category represents the smallest group in this study, made up of two female classroom teachers who have been working as educators for an average of fifteen years. One is a first grade teacher, the other a teacher of high school English. Compared to the other educators in this study, they have considerably less experience using technology in their classrooms for instructional purpose (less than five years). They have been drawn into using the Internet through a specific project or training program and are receiving ongoing, substantive support as they learn to use this resource. They have been using the Internet for less than a year, and are in the early phases of understanding and using the range of available resources. In spite of their novice status, they are extremely excited by their limited involvement with this environment. For example, the opportunity to exchange e-mail messages via the Internet, although hardly scratching the surface of the system, has intrigued these teachers and made them eager to learn more. They are aware that they know little about the workings of the Internet as a whole, and are grateful to the trainers working with them. In addition to working with experts who are training them in using the Internet, they are working in small teams with colleagues who are also novices, with whom they share ideas, advice, and resources. Their schools, which are either affluent or specialized science or technology schools, are investing in hardware, release time, and training, which all work to support the teachers' efforts. In general there appears to be an atmosphere of collegiality among teachers and administrators which surrounds the use of this technology.

Although these educators are technology novices, they are working in conditions that allow them to find the process of learning exciting, rather than insurmountable or frustrating. These two teachers describe the Internet as an exciting new resource, and imagine endless possibilities for applying it to classroom work. They recognize the central role their training is playing in their experience, and feel that training will be the most important factor in making the Internet accessible for other educators, including guided, structured training and demonstrations of real applications.

Evolving Understanding

> We want to work with other schools but have not made solid connections through the Internet yet.
>
> I did not think it was this complex. I thought it would be a lot more manageable.
>
> All I wanted was a way to reach other people on other networks and access the resources that I heard about...
>
> Time seems to be the biggest obstacle - time to explore. Right now I'm 'wrestling'....

A third of the teachers in this study are in the middle of a difficult learning process -- they are struggling simultaneously with technical and conceptual obstacles as they try to explore the Internet, often on their own. Two teachers in this group, one male and one female, teach traditional disciplines in the classroom; both are science teachers. The other four include two technology teachers, one male and one female, a district coordinator (female), and a librarian (female). They have been working for an average of twenty one years as educators.

These teachers average eight years of experience using technology for instructional purposes, and have been using the Internet for between one and two years. This eight-year average, which places them far above average in technology use among teachers, strongly suggests that these teachers are comfortable and competent users of educational technology (Becker, in press; Sheingold & Hadley; Honey & Henriquez, 1993).

Four of these six educators are the only Internet users in their schools, and inform other teachers of resources and activities they discover via the Internet. They all describe themselves as self-taught. They have minimal support from their schools (i.e., paying for one phone line), but feel they are essentially on their own in their efforts.

Specific projects, or specific goals (e.g., accessing TERC's Global Lab bulletin board on EcoNet, particular penpal exchange projects), were central in motivating these educators to get on the Internet. They rarely articulated a general desire to explore the Internet, or a self-motivating fascination with the technology. After a year or two of mastering the skills needed for a particular task, or while still in the midst of discovering them, these teachers are finding themselves essentially alone with a resource which they do not fully understand, and they are working in environments that offer little support for further exploration.

Consistent with their own current frustration and determination, these educators consider a range of issues all to be crucial to making the Internet a viable resource for educators. These include keeping costs low, offering training, developing educational content, increasing phone line access, and making the network easier to use. These educators are in the midst of a difficult learning process. While they are preoccupied with technical obstacles, they are also struggling to form a coherent understanding of the makeup of the Internet. They have encountered, and they are hopeful that they will continue to find, useful resources on the net. However, they are consistently encountering a wide range of logistical and technical difficulties, and they lack resources in their local circumstances that would make it easier to overcome their current difficulties.

Cautiously Optimistic

> ...It has proven as difficult to learn as the streets of a large urban area. Many of the resources appear more useful than they turn out to be.
>
> The Internet is very unmanageable. I didn't know how to navigate through it. It is very unfriendly and I get kicked out; without knowing why – whether it was my fault or theirs... There are also not enough resources.
>
> If you don't have a high tolerance for frustration and a self-defined construct or image of how this all works, don't jump on the Internet.

Another third of our respondents are cautious in their optimism about the value of the Internet as a K-12 resource. The six educators in this group have been working in education for an average of twenty-one years. They are very knowledgeable users of educational technology–thirteen years of experience on average – and all but one have been using the Internet for more than two years. Five are men, two of whom are classroom teachers (high school English, middle school special education), and three are district technology coordinators. The one woman in the group is a librarian.

As experienced and largely self-taught Internet users they are primarily concerned about the level of training and development that they feel will be necessary in order for the Internet to become both a viable and a useful resource for other K-12 educators. All but one of these educators describe themselves as leaders or mentors for other teachers who are beginning to use the Internet. They are the primary users in their schools and districts, and feel that it is important to share their expertise with others who are beginning to explore. Not only are they sharing technical expertise, but are frequently ferreting out resources for colleagues in their schools.

These experienced educators stressed two interrelated issues in their discussion of their experience with the Internet. They arc very concerned with training issues. Through their own learning experiences, and in their current roles as trainers to their colleagues, they have experienced the frustrations and the rewards of Internet exploration. They articulate most strongly the need for coordinated training and support efforts for teachers exploring this new resource.

The cautiously optimistic users reported and demonstrated a high degree of familiarity with the range of resources that are available on-line, and expressed their disappointment with the quality and usefulness of those resources for the K-12 community. These educators have examined resources such as databases, reference materials, and discussion groups and often found them less substantive than they had hoped for, or often simply not appropriate to their needs as educators. Having explored a wide range of Internet resources, the cautiously optimistic group is now quite vocal about the need for more and better K-12 content. They also stress the importance of consistent and convenient access for classroom teachers.

Experienced Enthusiasts

> I have been using the Internet since 1986.... I was captivated, and began my explorations....
>
> My vision has drastically grown from the idea of a resource to the idea of virtual schools....

> I like to be on the cutting edge and see the vision of the Internet expanding and being used even more. It is a mechanism in search of applications.

The four Experienced Enthusiasts in our sample are teachers who have brought a high level of technology-related knowledge into their teaching. They average fourteen years of working as educators and more than eleven years of experience with educational technology. What distinguishes this group from the others is their highly technical backgrounds and/or advanced degrees in technological fields. They are individuals who came to education from other professions such as computational science and engineering. They are also distinguished from the other groups by their long-term involvement with the Internet – averaging more than four years of experience. There are two women and two men in this group. The two women are technology specialists, and the men are a science specialist and a social studies teacher. They are all in specialized or affluent schools which have resources to invest in technology use. Each of these educators is unique in their school in their level of use of the Internet. They are all invested in training other educators in their school, district, or region. While some of this training work is supported by their schools, some of it is done independently and on the educators' own time. All of these educators describe themselves as self-taught Internet users.

The experienced enthusiasts feel that providing adequate access to the Internet is crucial to K-12 education. As one educator from this group states, "Put a computer on every teacher's desk with Internet access." Another teacher proposes, "Give every teacher a computer and modem at home." Their concern for flexible and continuous Internet access is more prominent than the emphasis the Cautiously Optimistic group places on the training needs of their colleagues. Their highly technical backgrounds have most likely made the Internet a more transparent resource than it appears to be to less technologically-savvy teachers, and make it possible for them to enthusiastically embrace the Internet as a rich resource.

Discussion

The Internet offers a way to gain access to people, services, and resources that could potentially transform the workings of teachers' professional lives. The possibilities for connection and communication that the Internet affords can significantly change the way teachers think about their own and their students' relationships to the rest of the K-12 community, and to the world at large. However, as the voices we have represented in this paper make clear, the obstacles to making the Internet accessible, viable, and meaningful for K-12 education sometimes seem as vast as the current ocean of Internet activity.

Increasing numbers of educators are already making use of the Internet – sharing ideas with colleagues all over the world, collecting data from faraway places and investigating elaborate libraries with their students, and conversing with their friends, their relatives, and often with complete strangers. But who are these teachers? Our small sample suggests that they are extremely technologically sophisticated, that they draw on skills and expertise that they developed outside of their professional role as teachers, and that they are working in schools which provide, at a minimum, an adequate level of access to hardware and release time – and often provide a great deal more. Clearly, few teachers come close to matching this description; even among the teachers represented in this sample only the experienced enthusiasts are likely to be carrying out all of the activities described above with consistent success.

While there are distinct differences among the educators represented in this study, it is important to recognize that even those described as novices here would be classified as highly technologically sophisticated when compared to the nation's teachers as a whole. Becker's (in press) research on teachers who are accomplished users of technology in the classroom has found that these individuals represent approximately 5% of the country's teaching population. We estimate that it is a small minority (approximately 2% of this 5%) of these accomplished teachers who are actively using the Internet. So what needs to be done to make the Internet a more friendly environment that can accommodate swimmers and drivers, as well as those just learning to walk? A number of issues -- some conceptual, some concrete, all interrelated -- need to be addressed.

Multiple metaphors

For an isolated, novice Internet user, with no expert colleague available for help and guidance, plugging away on a 1200 baud modem in the back of the school library during lunch period, the Internet is no information highway. It is complicated; it is arcane; it is obstinate. And for a knowledgeable district technology coordinator trying to find useful resources for an enthusiastic foreign language teacher, the Internet may not seem like much of an ocean -- rather than rich in resources, it may seem paltry and insubstantial; rather than endless, uncharted, and fascinating, it may seem arid and dull.

The experts, the developers and the researchers who help to bring the Internet into schools need to be thoughtful about and receptive to the multiple, and probably diverse, metaphors that educators bring to the experience of learning to navigate this conceptually difficult technological space. They need to incorporate these metaphors into their work, and disseminate images of the Internet that encourage complex, rather than monolithic, descriptions of how this space may come together in the mind of any individual user. Additional research in this area could inform design work, facilitate the development of training materials and programs, and continue to enrich and enliven the evolution of our conceptual understanding of the Internet and its communities.

Support and Training

Regardless of their level of experience, the teachers who were more positive about the usefulness and excitement of using the Internet in their teaching were teachers who were working with groups -- who were engaged in an ongoing process that involved both extensive training from experts and consistent support from colleagues. Training opportunities for teachers need to be supported by administrators, who make the time available. There are many potential avenues to creating training opportunities -- on-line courses, such as those developed by Montana's Big Sky Telegraph, front ends that control what resources are available to a user and open up the system gradually as the user becomes more knowledgeable, such as Texas's TENET; graphical interfaces that bridge the gap between users and resources, such as the GUIDE developed by the California Technology Projec;, university or research institution partnerships, such as TERC's Global Lab Project; in-school specialists; and collaborations between technology specialists and librarians/media specialists.

Administrative and Pedagogical Flexibility

Every educational innovation introduces new strains on teachers' schedules. Gaining an understanding of the Internet may, in the long run, make some tasks easier and quicker for teachers, but learning to use the network requires an intensive investment of time. Few teachers have adequate time in their schedule for meaningful, substantive Internet training. Some of our respondents felt strongly that home access was the answer to this problem -- that giving educators access to the Internet on their own time, in their own home, provides an opportunity to explore, make mistakes and discover new tools that could not be duplicated in the school. However, this cannot be an adequate solution on its own, and school administrators need to commit to supporting their teachers in learning such a significant new skill, whether through summer workshops, in-service training, or pre-service programs.

In addition, many educators in this study stressed the value of their working relationships with colleagues. In order for teachers to experiment with the new roles that telecommunications can play in their classrooms, flexible structures such as team teaching, interdisciplinary work, and shared planning time must be made available.

Better resources for the K-12 community

The Internet was not designed with the K-12 community in mind. Neither was the vast majority of resources currently available on-line. Too often, enthusiasm over the potential the infrastructure of the Internet offers for changing relations between K-12 professionals, students, and institutions and the rest of the world is equated with enthusiasm for the resources currently available on the net. Even if educators gained total access to the Internet tomorrow, a great deal of work needs to be done to provide adequate answers to the inevitable question, "What can I, a classroom teacher, do with this?" While it is clear that there is a need for better navigation and search tools, and for improved directors and pointers to K-12 resources, it is clear that there is a great need for well designed, substantial, and relevant K-12 resources in a range of content areas. Such resources can range from student-produced historical archives, like the Armadillo gopher in Texas, to inservice professional development courses such as the Mathematics Learning Forums Project at Bank Street College.

Access

When these educators mentioned the need for greater access, which they did frequently, they most often meant some combination of four things:

> *Phone lines.* In some cases, our respondents were struggling just to get one phone line in their classroom. Others had discovered that they needed multiple separate lines in the building so that more than one telecommunications activity could go on simultaneously. Teachers are the only group of professionals who do not have regular access to telephones, often because the cost of installing phone lines in school buildings is prohibitive. The cost of installing phone lines in schools is often prohibitive because schools are charged business installation rates. There need to be federal incentives that encourage the private sector to support the K-12 communities in gaining access to the Internet.
>
> *Accounts.* Some teachers are locked into specific providers, which may or may not be the systems they would like to use. Others are paying out of their own pockets for their accounts, and need district support with registration and on-line fees. Others find themselves having to cajole less-than-sympathetic universities to provide them with basic access. While such arrangements speak to the dedication of the teachers involved, in the long run dial-up connections via low-baud modems to distant nodes may be at best a complex and at worst an unreliable means of connecting to the Internet. Implementing inschool local-area networks connected to wide-area networks outside of the school is a design which is currently being promoted at BBN Laboratories, among others, and which offers great promise (Newman, Bernstein & Reese, 1992; Newman, Reese & Huggins, 1993). Securing this kind of reliable and direct connection to the Internet is crucial if we expect teachers to make substantive use of the net and be active contributors to the growing body of K-12 content.
>
> *Hardware.* A number of these educators have computers in their classrooms, but many are communicating from libraries, department offices, or their own homes. Few if any schools have enough machines to involve more than a few students in telecommunications activities at once. Using the Internet does not require a powerful computer (although having at least one high speed modem available for large FTP files, etc., is helpful) but if students are to become meaningfully involved in activities using the Internet, multiple computers in teachers' classrooms are necessary.

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Using the World Wide Web to Build Learning Communities in K-12

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> Many are the conditions which must be fulfilled if the Great Society is to become a Great Community .... The highest and most difficult kind of inquiry and a subtle, delicate, vivid and responsive art of communication must take possession of the physical machinery of transmission and circulation and breathe life into it. When the machine age has thus perfected its machinery, it will be a means of life and not its despotic master. John Dewey (1938)

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Abstract

Social accounts of learning and human knowledge have led to attempts to reorganize schools as learning communities. This paper examines the utility of the World Wide Web (WWW) for aiding in the construction of school-based and work-based learning communities. An ordered list of interactions is provided to characterize the depth of students' entry into new learning communities. Current offerings on the WWW are then surveyed in terms of these categories. Finally, proposals are advanced for enhancing the architecture of the WWW to facilitate its use for the creation and operation of learning communities.

1. Introduction

Social accounts of learning and human knowledge (Dewey, 1938; Kuhn, 1962; Toulmin,1972; Vygotsky, 1978; Wittgenstein, 1967) have led to attempts to reorganize schools so as to form learning communities(1). In general, two different senses of learning communities have been advanced. First, are school-based learning communities formed by students and teachers who engage in long-term projects; where students work together collaboratively, thus allowing them to learn from one another; and use the problems to be solved to dictate the knowledge that must be acquired, thus frequently and purposefully crossing disciplinary boundaries (Hill, 1982). Second, are work-based learning communities where students learn the practices of a discipline or profession, with the historical example being apprenticeship. Here the profession defines a "community of practice" that the student aspires to join; this term refers broadly to the practices of a field, its social organization, and its mores. This method of learning through apprenticeship has been characterized as becoming a legitimate peripheral participant (Lave & Wenger, 1991). Schools can play a role here too by helping connect students and work-based learning communities and encouraging students to reflect critically on the communities in which they participate. In fact, these are functions many professional schools commonly perform. Essential to all types of learning communities is access to resources and communication. In this light, it is argued herein that *computational communication technologies* (CCT)2, and, in particular, the World Wide Web, can play a vital role in the formation and successful operation of learning communities.

2. Role of Communications in Learning Communities

Learning communities are difficult to build because they have high social and material requirements. School-based learning communities that are attempting to engage in long-term inquiry require access to specialized information, to practitioners, to relevant data and analysis tools, and the means to create arguments and representations so as to negotiate disagreements through them. For example, Dewey proposed that students investigate the history of changes in cotton production and the impact of those changes on the experience of the workers. Such a survey requires students to trace through the history of technological innovations, interview current workers and investigate the lives of former workers, and to express and discuss their results. A CCT could expedite these needs enormously by, for example, providing ready access to historical documents, books and reference material; providing the means and medium to communicate with appropriate workers; and helping students to structure their discussion via specialized hypertextual media that reify argumentative structure (O'Neill, Gomez, & Edelson, 1994). The needs of students in work-based learning communities are similarly demanding, including the need to learn about community practices and products, find participants in the community who are looking for an apprenticeship, build and store an accessible portfolio of work, and reflect and critique the apprentice experience. Clearly, a CCT could be useful here as well. It could be argued that apprenticeships have successfully been conducted for thousands of years without the need for CCTs, yet this would miss the point that these new connections to work-based learning communities are not necessarily designed to turn the students into life-long professional practitioners but rather to provide an opportunity for them to understand and investigate a field -- or more to the point, to investigate many fields. The success of apprenticeships historically has demanded years of service where the initiate was immersed in all aspects of a profession. The hope is that shorter, more focused, and more varied experiences can serve to educate students on a variety of fields, thus providing them with the ability to integrate diverse expertise and to choose a field based on experience, rather than inheritance or chance.

In learning communities students must connect to communities of practice (e.g., when a school-based learning community picks as a class project to build a sturdier or more agile kite it should profitably engage the knowledge of aerodynamics, kite manufacturing, and the atmospheric sciences). Hence, it is useful to characterize the types of interactions students may have with communities of practice. The following list is designed to describe increasing levels of interaction with a community of practice or fuller levels of participation:

1. Students access published work, such as papers, figures, presentations, and analyzed data.
2. Students access tools and raw data such as, equipment for production, laboratory procedures and materials, community developed data sets, and analysis tools.
3. Students dialogue with community members, either written or oral , such as exchange of letters, email, telephone calls, and interviews.
4. Performance of joint coordinated activities between students and work-based learning communities, such as performing an experiment together or planning collaborative activities.
5. Incorporating student work into published archives of a community's work (e.g., when scientists collect and use student collected data).

This list will be used to organize the discussion found below of how the World Wide Web (WWW) can be used to form learning communities. The intended value of these categories of use is that they be used to guide next generation WWW application design and future technology adoption strategies. Hence, it is necessary to describe briefly the WWW and the rapid process by which it has become a dominant technology.

3. The World Wide Web

In the early and mid 1980's the Internet and inter-networking were dominated by the technical and research community. It was a special-purpose information preserve for the support of communication and inquiry. Starting in the late 80's and continuing into the early 90's, the Internet experienced explosive growth. For example, in 1987 the number of Internet hosts exceeded 10,000, in 1989 the number of hosts exceeded 100,000, and in 1992 there were over 1,000,000 Internet hosts (Zakon, 1994). Much of this growth did not come from more technologists and researchers joining the network but from non-traditional entrants to the network community. In particular, students and teachers were introduced to email, news groups, listservs, ftp, and gopher, thus causing a significant part of the network's growth. In a similar fashion the WWW, the most important recent innovation in Internet Protocol technology, have gained a significant foothold in the technical community and are now expanding rapidly into the world beyond the research community, including the K-12 community of students and teachers.

Paralleling the exponential growth of the Internet overall has been the growth of the WWW: Only 18 months ago, there were but 100 WWW servers on-line worldwide; today there are over 10,000 WWW servers, and current estimates predict 100,000 a year from now (Gray, 1994). This decentralized development of information resources, for everything from scientific databases to corporate products to traffic and weather reports, is an exciting development for lifelong learning and for education and training.

In the discussion that follows we survey several current applications of WWW technology in K-12 learning situations. The survey follows the categories proposed above, detailing students' increasing participation in communities of practice. Our survey is not meant to be exhaustive. Indeed, due to the very decentralized nature of the network, an exhaustive report may be impossible. We do, however, attempt to describe several example K-12 uses of the WWW that are illustrative of the breadth of use and might be indicative of where school people and others in learning communities may be taking the WWW.

Following our brief use-survey, we will speculate on how current WWW technology and its potential evolution support the needs of learning communities. Finally, we use both our characterization of WWW use and speculation of its evolution to argue that there are specific needs and identifying characteristics for WWW servers developed for educational purposes. Of course, it is likely that any information resource on the network can be learned from, just as any book from the library can offer learning opportunities, whether it is specifically planned for educational uses or not. The potential value of all information resources for learning notwithstanding, it seems to us that a broad set of guidelines for educationally focused WWW servers will spur both new application design and widespread technology adoption in schools and other learning communities.

4. Access to Resources

The search for reference and archival information for reports, projects, and other activities is a large part of school work. Thus, students commonly go in search of information in their school and public libraries. Often, a short passage in an encyclopedia meets the student's need, where their goal is merely to summarize commonly accepted information and standard interpretations. However, when students engage in school-based learning communities they must do more than be passive collectors of previously digested information. In pursuit of long-term projects and in defense or controversial hypotheses, students must find relevant information. The emphasis is on the student's using the information, not merely reporting it; developing, stating and defending a position, not merely repeating a status quo. It is in these information-seeking situations that we believe the WWW will be most valuable to the K-12 community. Its value stems from the way in which organizations act as publishers for themselves, allowing them to quickly place their new work on-line and to express clearly their own point of view. These distinctive points of view are in one sense biases and therefore inimical to the student knowing the "truth." Yet, this is precisely the antidote to overly sanitized textbooks that is needed. Before students can decide what they believe they must become aware of the range of existing opinions and identify at least some of them as ones they do not believe. Hence, as students combine information from more traditional sources with WWW sources, they originate their own point of view, including critiques of alternatives.

Because of the individualized medium of publishing on the WWW, its diversity nearly defies exposition. Examples are used to illustrate this enormous array of information. However, these examples can barely scratch the surface of what is available. Our aim is to show utility to students, rather than to provide even a representative summary.

The information resources for K-12 education provided by the WWW can be divided into the following five categories:

1. Libraries
2. Museums
3. Government Information
4. Curriculum and Activities
5. Indices

These categories are a mix of information sources and information format types. However, this mixture accurately reflects the dominant ways that material is currently organized within the WWW. Entries are jointly organized by institution (e.g. universities or libraries) and form (e.g. plain-text article or hyper-text index).

Libraries

The potential for communication networks to amplify the reach of libraries is being pursued by many libraries, as can be seen in the variety of offerings on the WWW. A noteworthy site is the North Carolina State University library (Morgan, 1994) which, in addition to books, provides links to popular periodicals like Mother Jones (1994). Perhaps the quintessential vision of on-line information access for the "information superhighway" is placing the Library of Congress on the network. The difficulties in converting its current vast holdings of paper books into digital media also illustrates the distance that must be covered. However, the first step in this journey has already been taken, as can be seen by the Library of Congress's home page (1994). The general vision is simple and powerful: place the holdings of the Library of Congress on-line coupled with flexible search engines, thus providing unprecedented access. Students could pursue virtually any topic, no matter how obscure or popular, without having to worry that the book is not in the inventory of their local library or had already been checked out.

Museums

Museums, like libraries, are great bastions of culture in our society. They, too, have come on to the WWW, providing provocative and useful resources for students. For example, the Exploratorium Science Museum in San Francisco (1994) provides "virtual-exhibits" designed to aid in the understanding of scientific principles and concepts. A Museum of Paleontology has been erected on the WWW by the University of California at Berkeley. A diverse collection of dinosaur images and information provides a particularly welcome resource for K-12 students, who are often fascinated by our gigantic ancient predecessors. Through these new venues, museums and libraries are continuing their primary task of providing access to cultural artifacts and descriptions of nature. However, the possibilities of access at a distance to so much of their collections introduces order of magnitude differences in the level of access that can be achieved. Of course, these possibilities come at the cost of redefining what is being delivered. Providing a picture of a dinosaur is much different than standing before a fifty-five foot high reconstructed skeleton: The agreed upon "stand-in" for nature has been transformed.

Government Information

Government information provides a treasure trove for those hoping to understand our society and to those seeking to play watchdog. For example, through accessing government information and statistics, students can re-evaluate newspaper editorials and study the human impact on the environment. Towards the latter end, the Environmental Protection Agency (1994) provides numerous data sets and statistics. Similarly, the United States Geological Survey (1994) provides information and curriculum units. Another example is the United States Bureau of the Census (1994) which publishes data and analyses through the WWW. Through analysis of these governmental data sets, students can examine anthropogenic changes in our environment and evaluate what populations will be affected, including both the number of people and their demographic characteristics. The goal is for students to acquire a deeper sense of their own local area by summarizing its characteristics and contrasting them with other areas. Another valuable resource for such activities comes from an enormous collection of declassified military spy photographs collected over the past 25 years (United States Geological Survey, 1995a) in the hopes that students and researchers can use them to detect changes in our local and global environments; however, currently only a few demonstration images are available over the WWW. The legislative branch of government is publishing the full-text of legislation and the congressional record through the web (United States Congress, 1995).

Curriculum and Activities

The examples above were intended to illustrate the utility of these data sets and also to suggest the tenor of potential projects: Students can go beyond merely reporting facts and figures to using them in service of testing or promoting a theory. Often students need guidance to use effectively the information that can be found in remotely accessible libraries, museums, and government data bases. A traditional way to package such guidance is through prespecified activities or a curriculum. Thus, the WWW provides a new medium to deliver these curricula. An exacting procedural example is provided through a lab experiment to dissect a frog, turned into a WWW interactive session by the Instructional Technology Program at the Curry School of Education, University of Virginia (Kinzie, 1994). Ample use has been made of images that illustrate the steps involved in the procedure. In addition, snippets of video are provided that show students going through these steps, thus providing a model to imitate. This multi-media presentation permits specification of the laboratory procedures well beyond what can be provided in a textbook. Further, the text, images, and video are flexibly intertwined, thus providing a more integrated context than a videodisk. An even more ambitious effort is demonstrated by the Education for Gifted Youth Program (1994) from Stanford University which attempts to provide entire courses in mathematics for gifted high school students. In contrast to coordinated presentations like these, other WWW servers provide lists of curriculum that are available. For example, the Explorer Project (Unified Network Informatics Technology for Education at the University of Kansas, 1994) provides extensive listings of educational material in the areas of math and science, some of which can be obtained directly over the WWW. The utility of superb images is exemplified by the University of Illinois Atmospheric Science department, which has assembled pictures of various types of clouds (Atmospheric Sciences at University of Illinois at Urbana-Champaign, 1994). This Cloud Catalog consists of unique photographs (slides) of different cloud types, ranging from Cirrus Fall Streaks to the Funnel Cloud. These pictures have been scanned in and are accompanied by descriptive information identifying the cloud type.

Indices

Simple textual searches are not sufficient to index information. Often more useful are indices to information sources that have been created. Many of these indices are organized by subject matter, author, or other standard criteria. Automatic creation of indices exist both by the WAIS searches of selected data bases and by "robots" or "spiders" (e.g., Eichmann, McGregor, and Danley, 1994) that crawl through the WWW and compose traces of its paths and by-ways. In particular, the Lycos search engine from Carnegie-Mellon University (1994) provides a superb facility and was used extensively in the preparation of this paper. However, pattern matching on text is not sufficient. Richer and more flexible indexing strategies are needed. In fact what have emerged are trailblazers (as proposed by Vannever Bush, 1945) who map out whole networks of associations that are worth following -- in fact, this section itself could be viewed as an attempt to trailblaze. In addition, pragmatic indices can be created that are designed to help accomplish tasks (as opposed to subject indices that group together material on a similar topic). Alternatively, students' exploration of the WWW may be best facilitated if they are able to list their goals flexibly and explicitly when accessing a link, thus providing the opportunity to maintain an external memory and executive assistant. In any case, the pragmatic structure of the information and resources being provided by the WWW must be more clearly conveyed so that students can mine its extraordinary riches.

5. Access to Analysis Tools and Raw Data

A more sophisticated level of access for students to communities of practice provides them the ability to generate custom representations and obtain access to the underlying data, thus permitting novel analyses and interpretations. Often, the form of the data is dictated by the representations employed. These representations are often very complex in that they are highly encoded and are layered on top of other representational systems (Latour, 1988). Not yet present in any of these systems is an attempt to provide scaffolding for novices through the provision of rich contextual information that would deconstruct the representations and provide examples of how these images, data, and tools have been successfully used in practice. This is unfortunately similar to how scientific laws have been presented in didactic classrooms -- formulas presented absent the situations in which they provide explanatory power, thus posing a puzzle to the student as to why they are valued (Toulmin, 1953). Nonetheless, the appearance of these dynamic tools is an important step in moving education beyond a model of student as consumer to a model of student as active inquirer. The examples presented here are grouped by domain as follows:

1. Weather maps
2. Scientific visualizations of climate
3. Interactive Mapping

Weather Maps

Purdue University's Department of Earth and Atmospheric Sciences (1995) has developed a server that allows students to select weather images and data that is updated hourly, thus allowing students to do weather prediction and investigation.

Scientific Visualization

The tools used by an expert community often serve to help define the basic questions and assumptions used. In particular, scientists in recent years are employing scientific visualizations(3) (SciVs) as a primary means to communicate discoveries and to perform speculative investigations. The extent to which they have permeated scientific practice is demonstrated by picking up any recent issue of *Science* or *Nature* and counting how many SciVs can be found. A common use of these visualizations on the WWW is to provide the ability to browse data sets in order to refine one's choice of which data to request. For example, the Lamont-Doherty Earth Observatory of Columbia University (1995) will dynamically render climate data sets as directed through a vast array of parameters as well as provide the underlying data to the user. Similarly, the Pacific Marine Environmental Laboratory of the National Ocean and Atmospheric Administration (1995) renders several oceanic data sets and will deliver the data in spreadsheet form. Another example comes from the Learning through Collaborative Visualization (CoVis) Project at Northwestern University (1993). Practicing atmospheric scientists were interviewed and their methods and data analyzed, leading to the design of specialized educational software where the students could peruse and construct SciVs of climate and the earth's radiation budget (Learning Through Collaborative Visualization Project, 1995a). These visualizations are provided at multiple levels of detail so as to aid students in detecting large and small grain patterns within the global climate system. Individual points can be queried for their value; by choosing different levels of resolution these data points can refer to relatively small areas (e.g., 2.5 degrees square) or to large areas (e.g., a single scalar for the whole earth).

Interactive Mapping

Evaluating the data that can be obtained over the WWW often requires flexible tools that allow the iterative selection of data and analytical operations on it. Tools like this are becoming increasingly common on the WWW through the use of forms. An example of a WWW server providing interactive analysis of data (even before the introduction of forms) is provided by Xerox's map server (1994). This server facilitates the interactive exploration of digital maps through the operations of selecting a part of the globe, zooming in on the globe, and specifying what aspects to portray (e.g. rivers or political boundaries). In this manner, not only is information provided, but an environment for querying and investigating that information is specified. A fascinating example has emerged of an application that combines the information on recent earthquakes with the Xerox map server to provide customized maps of where recent earthquakes have occurred. Hence, by providing applications on a common global platform new applications can be built by linking others together. This philosophy of linking pieces to create larger wholes is fundamental to the methodology of computer science and has been a primary goal of many operating systems (e.g., Ritchie & Thompson, 1974) -- the WWW now provides such a global operating system for interactive applications. Of course, the emergence of standards for inter-operability should substantially enhance the ease with which such applications can be created.

6. Forging Learning Communities through Communication Mediums on the WWW

This section focuses on how the WWW is being used to forge learning communities between students, teachers, schools, and professionals. The emphasis is on those using the WWW as an interactive(4) communication medium and on sites whose primary goal is to establish learning communities. Interactive mechanisms are still relatively undeveloped on the WWW, but include forums which are similar to newsgroups (messages can be posted and read asynchronously) and chat sessions which emphasize synchronous communication through entering short messages. These facilities have possibilities not shared by their progenitors, namely Usenet newsgroups and Internet Relay Chat (IRC). These possibilities arise from the flexibility of the WWW to incorporate multimedia, hypertextual links, and structured forms. Some of these advantages are realized in the communication media reviewed below, in particular, that allow students and teachers to create logs of their activity and in their collaborative construction of web pages. However, we expect the development of interactive structured communication like these to be one of the most important developments for the establishment of learning communities. The examples provided here are grouped into the following categories:

1. Connecting teachers and students with one another
2. Connecting parents and local communities with schools
3. Connecting students to scientists and other practitioners

Connecting teachers and students with one another
This category is broad in that it refers to connections both within a single classroom and across classrooms. The Gonzaga College High School in Washington DC (1995) Earth System Science Community Curriculum is using their web server as the basis for students to file progress reports where they record their activities, list problems or questions, and enumerate the resources they employed that day. Teachers similarly file reports. These reports are available to the entire community, indeed to the entire WWW, though selected portions (e.g., the teachers' reports) are password protected. These communication facilities are integrated into a comprehensive set of services that provide relevant scientific instruction and data, bibliographies, and relevant papers for students to use in accomplishing their project. These facilities provide an excellent example of how the WWW can be used to forge a school-based learning community that is also open to work-based learning communities in that scientists and others could potentially serve as mentors by observing the students' on-going work and through understanding the suite of tools and data that help comprise the environment in which they are working.

The CoVis Project has established WWW pages that students and teachers collaboratively construct by adding WWW sites along with a description and annotation (e.g., Learning through Collaborative Visualization, 1995b). These pages serve as a place to share key "finds" on the WWW with each other. Another example of annotating the web is the provision for newsgroup style threads that optionally include pointers to WWW pages (Learning through Collaborative Visualization, 1995c).

Another exemplary project is Web66 (1995a) which helps teachers and schools to start publishing on the Internet by setting up ftp, gopher, and WWW servers. While this style of communication does not fit with the interactive motif of this section, Web66 does provide for interactive communication by maintaining a listserv that connects educators supporting WWW servers. Another excellent service provided by Web66 is a comprehensive list of K-12 WWW sites (Web66, 1995b).

The Global Schoolhouse Project is also seeking to build a community between schools. Their WWW server (Craighead, 1994) provides an asynchronous electronic spine as a repository of diverse information including: a description of the project's goals, a list of its participants organized by school with home pages for teachers and students, a "hot" list of software being used by the project (i.e., clicking on the name of a piece of software transfers it via ftp) and access to mailing lists and curriculum.

Another area where efforts have been started but are not yet well developed is in establishing a learning community amongst teachers. This is particularly important since teachers are often shut off from professional contact with their fellow teachers and researchers because of the physical architecture of educational environments, namely, separate classrooms with one teacher and many students. CCT can provide vital links between teachers, thus allowing them to share professional advice and to adopt new practices and methods. Mechanisms of fostering such change are crucial if new technologies are going to be successfully incorporated into classrooms without having to wait for an new generation of teachers to enter the profession. An example effort in this regard is the Texas Education Network (Tenet) project which is seeking to forge community and expertise amongst the state's educators. One aspect of this is their WWW server (Texas Education Network, 1994) where a wide range of information can be found, including legal, technical, and practical aspects of telecommunications.

Connecting parents and local communities with schools

One advantage parents can provide students and teachers is that of an interested audience. The primary audience for students are teachers, thus providing an audience which is vastly outnumbered by the performers. When a school uses the WWW to make student work available to the broad-based audience of the Internet, students suddenly have a new, and greatly expanded, audience for their work. A number of schools have started to make student work available in this way. Two notable examples are Grand River Elementary School (1994) in Lansing, Michigan, and Hillside Elementary School (1994) in Cottage Grove, Minnesota. Both of these schools assist students in creating their own personal WWW pages, in effect giving the students a personalized presence on the Internet. In an analogous attempt to allow parents access to school life, many schools, especially in urban areas, have begun using "voice mail" systems. These systems allow parents to phone the school, and through a series of touch-tone commands, learn about their child's attendance record or daily assignments. These systems have been very successful in alerting parents to the work their students should be doing, and aiding parents in monitoring homework and academic progress. If a school is able to make student work available on-line, a leap is made from showing parents what students should be doing to what students are doing. Beyond seeing their own child's work, parents would be able to view the work of other students. This allows parents to see how their child compares to others, so that they can make a self-determination of academic progress that is based upon quality of output, not on grades or class rankings. Furthermore, through the addition of a forms-based interface, parents could provide feedback or critique on their child's work, adding another dimension to its evaluation.

Local communities serve as another primary audience and source of resources for schools. The WWW can serve schools as an alternative mechanism to communicate with their local communities. For example, people who live in Arlington, Virginia (1994), can get current information about their local public schools on-line. The Houston Independent School District has taken advantage of the excellent Armadillo WWW server at Rice University to announce the mission statement for a new lab school (Perkins & Castellanos, 1994). The Cottage Grove Elementary School makes community statistics and information about its PTA (Hillside, 1994) available on the same WWW server its students use to produce their personal home pages.

Putting students in touch with experts
Few if any WWW sites have facilities to put students in direct contact with practitioners, experts, or scientists. Instead, the WWW is helping to publicize mechanisms outside the WWW by which such contact can be arranged. For example, the United States Geological Survey (1995b) advertises its "Ask-A-Geologist" service.

7. Collaboration between Students and Work-Based Learning Communities

Again, the WWW is not being used directly to accomplish collaboration between students and practitioners or experts. Instead, some WWW servers are helping to publicize efforts that are occurring using other communication facilities. One of the most fascinating of these is the JASON project which seeks to build community by having students participate in scientific field trips remotely through a "telepresence." Such trips are accomplished through highly advanced robots that are capable of exploring the depths of oceanic vents or the inner molten reaches of volcanoes. Students participate by suggesting courses of action and asking questions. Jason's WWW server (Feldman, 1994) aids in this process by providing a basis for teacher in-service education, dissemination of curriculum, and multimedia recapitulations of past explorations.

A possible future use of the WWW to foster communication and collaboration between students and practitioners is to provide a mentor data base. Students would list the type of help they are requesting, while practitioners would list their areas of experience. Further, logistical constraints could be incorporated, such as available time, preferred modes of communication, and so on. This database could then be used to do matchmaking between students and practitioners.

8. Adopting students work into a community of practice

In this area as well, the WWW does not yet have many facilities for students to build or engage in collaborations with practitioners. Hence, we again concentrate on WWW servers that describe such activities conducted through alternative mediums. In particular, the Global Lab Project at the Technical Education Resource Center (TERC) is linking classrooms around the globe with each other and with experts in order to accumulate student data for scientific use. One project had students around the United States collect experimental data on acid rain and then pool the data for analysis by experts in the area. This effort produced a unique and valuable resource for environmental scientists. Recent efforts are seeking to have students collect data on levels of ozone and other substances crucial to observing patterns of global environmental change. The international flavor of the project is conveyed by their WWW server (TERC, 1994) which contains movie clips from Global Lab classes in Nigeria, the Czech Republic, Mexico, and Washington, D.C. A strength of TERC's projects is that they have found ways for students' work to be of genuine use and of interest to scientists, thus providing the basis for a relationship based on mutual benefit. This is consonant with the philosophy of their chief scientist, Robert Tinker (1994), who seeks to transform students and schools from isolated islands of concept learning into powerful social resources. In a similar vein, Vice President Gore (1993) is leading Project Globe, which has called for scientists for organize and lead student data collection into environmental conditions, such as air and water pollution, stratospheric ozone levels, and carbon-dioxide emissions.

In summary, WWW servers provide valuable aid towards the goal of enabling schools to forge learning communities. WWW servers serve as central repositories of general project information, software, expert tools, home page biographies, and mailing lists. In this way, the WWW servers provide a common infrastructure which all can access equally(5). This provides a place to accumulate results from more transient communication media like video conferences and email. WWW sites are evolving as a medium for newly formed communities to consolidate identities, and to build shared vocabularies and expertise. As the WWW evolves to support interactive communication more fully, it should prove better matched to the goals of creating learning communities.

9. The Need for WWW Educational Server Development Guidelines

To date, most resources on the WWW have been developed without the specific goal of fostering K-12 learning communities. Yet, as the above examples show, even without this aim WWW resources have been developed that are of extraordinary value to schools and learning communities. In order to continue to advance in this process of facilitating the construction of learning communities through the WWW, an explicit characterization of how to accomplish this goal is needed. The beginning point in this process is a recognition that Educational WWW Servers (EWS) are needed that embody a distinctive architecture. In particular, an EWS must embody the following features:

1. EWSs need to provide "just-in-time" curriculum for students. This style of curriculum differs from the standard prearranged sequences of material found in most textbooks and is organized so that students get access to resources they need in order to solve their current on-going problem. This style of problem-solving is no different than that employed by adults in the completion of their tasks. When an adult needs to build a bookshelf they usually do not engage in a four month sequence on wood working, but look up bookshelves in the index of a "how-to" book. Similarly, students will access curriculum resources in order to achieve their short and long-term goals. Necessary components of such a curriculum are:
   - ☐ Information resources such as those surveyed in section 4 above.
   - ☐ Activity structures must be provided that aid students to learn the conceptual structures of a domain (e.g., There is an overarching category that unites visible light with imperceptible radiation of longer and shorter wavelengths, that is, the electro-magnetic spectrum) and to build important artifacts for the investigation of physical phenomena (e.g., a pyrometer that can detect infrared radiation). These activity structures should identify materials required as well as place the activities into a social structure (e.g., performed as a small group or whole class). This is in contrast to the assumed model of use on WWW servers today, namely, a single individual accessing information.
   - ☐ Assessment procedures designed to aid students and teachers in understanding a student's level of competency in order to direct the student to the resources and activities described above. These assessments can also be keyed to educational standards such as Goals 2000 or district-based mandates. In short, an EWS must have more than content; it must also have that content placed into larger contexts of use. In addition, assessment procedures can help students monitor their own progress, thus promoting their executive and meta-cognitive abilities to direct their own learning.

   Matching resources to teaching and learning tasks is the primary design objective of an EWS and can provide rich opportunities for important new design work in computer science, networking, and learning sciences, particularly around issues of information access, intelligent agents, teacher development, domain cross-referencing, and cognitive development in the subject areas. Some preliminary ideas in this direction are enumerated in the section below on a geosciences EWS. In addition, work-based learning communities can aim to provide versions of their tools and data sets that are surrounded by a rich contextual background to help ease the difficulty of learning their use. This would involve, for example, making the units of the data explicit and their meaning explained in everyday terms (e.g., a joule is the amount of energy spent in lifting a lemon one meter, Emiliani, 1992).

2. The EWS should offer facilities for authoring and browsing user commentaries. These commentaries provide a living dimension to the EWS, so that it is continually open to the design work that its users are doing in seeking to utilize its resources in their local situations and for their specific purposes. Commentaries can discuss the usefulness of specific resources and the activity structures designed to

provide context for their use, and suggest modifications that "make them work better." This design goal of developing a self-improving or cybernetic EWS can provide a major advantage over any previous static educational innovation in curriculum. We would argue that it provides more of a free market for teaching and learning resources which is evolutionary in its nature (survival through use in selection) rather than top-down from instructional designers -- which is often too elite and ill-suited to the vicissitudes of local situation appropriateness in educational settings. In addition, these authoring facilities provide a means for teachers and students to originate their own curricular ideas and to engage in collaborative knowledge construction and debate. The investigation of how to structure hypermedia documents to facilitate learning communities has been an active area of investigation (O'Neill, Gomez, & Edelson, 1994) that can be utilized here in designing mechanisms to foster both divergent and convergent lines of thought.

3. The EWS also offers a facility for teachers and students to contact others on the network who share a particular interest with them. These contacts can be as simple as WWW entries containing email addresses or they can grow to be as complex as WWW-based protocols that assist teachers and students in making contact with people that have appropriate expertise at the time it is needed in a learning situation. The WWW is now poorly developed in its interactive communicative functionality. In particular, little has been done as regards either infrastructure or content to set up opportunities for work-based learning communities. Explicit attention must be paid to this issue. A primary critique of current educational practice is that it does not "transfer" to the work-place. As critiques of the notion of transfer have pointed out, connections between subject matter that transfer are not inherent, rather they are constructed via analogies and social agreement (Pea, 1987). The work and educational community must join together to forge connections between their, too often disparate, learning communities. Opportunities can be found for students to investigate issues and potentialities that the work-based communities do not have the time or energy to pursue. Building on Simon's (1969) insight that economic decisions are limited by bounded rationality, we can easily recognize that any decision we make is made heuristically within an ecological domain where all relevant resources are limited. Our schools provide a huge resource for performing additional research on these decisions. An obvious example is the researching of alternative energy sources, such as solar power. As technologies rapidly evolve, the economies of scale for energy production change -- students can provide an ever-ready pair of eyes inspecting such possibilities for fiscal viability. In addition, professionals work in established paradigms and modes of thought. These paradigms guide productive work, yet they can also blind one to productive alternatives. Again the eyes of our students can provide new hypotheses that incorporate more divergent influences or randomness than a fuller member of a learning community might provide. This random variation is the prerequisite for the evolutionary selection of ideas to occur. The professional community can easily critique and prune such ideas; the role of our students can be to generate and design new possibilities. Through these designs and the subsequent critiques, profound learning can occur. Imagine how much more valuable it would be for each class of our students to have proposed alternative energy sources, rather than for each individual student to be successful in passing a math competency exam. In addition to critiquing the work of students, work-based learning communities could be formed that would provide for mentoring of students, provide opportunities for joint work, and mechanisms to acknowledge when the work of students was sufficiently useful that it warranted further investigation or incorporation into the community's corpus.

   Overall, it must be emphasized that EWSs will only develop value for education insofar as educators and other educational agents (e.g., parent, peers, and workers) take action to advance teaching and learning design, usability, and promote their broader adoption. This serves to seed a learning web, and establish new distributed communities for educational reform.

4. Educational servers fundamentally need powerful search engines for specifying teaching and learning tasks by educators which then guide intelligent agent-based search throughout WWW servers. The kinds of considerations in designing such searches include query by progressive refinement around subject domain, topic within domain (cross-referenced interdisciplinary curriculum resources probably requiring indexing of some kind), grade level appropriateness (but ultimately learner level irrespective of grade). The key here is

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turning up resources that are "good enough," so that educators and users find that the time and effort costs of browsing and search are worth it, relative to the benefits derived for teaching and learning.

10. The Geosciences Server: a sample Educational WWW Server

EWSs, if they evolve, will take many shapes; below, we offer a characterization of one now being designed, that is, the Geosciences Server being built as part of the CoVis project. The CoVis Geosciences server is being developed by several institutions that include Northwestern University, University of Illinois, University of Michigan, University of Colorado, Exploratorium Museum, and select K-12 schools. Materials will include: curriculum, activities, assessment materials, data sets, editorially-reviewed student projects, directory services for participants, and a comprehensive indexing scheme. Part of the design effort is to seek to assure compatibility of server resources, materials, and activities with the leading state frameworks and emerging national science education standards.

The ultimate goal of the server is to develop a model for how communications technologies can aid the establishment of learning communities. One part of the design focuses on the delivery of curriculum so as to be useful to a school-based learning community. This curriculum incorporates the following parts:

1. An accounting of the basic conceptual structures of a field presented as a set of categories and processes. This account is consistent with cognitive science descriptions of how scientific knowledge is organized (Chi, 1992; Gentner, 1989).
2. Activities designed to help students move from their everyday categories to the specialized categories of science. These activities should accomplish this by demonstrating the worth of the categories. That is, the categories should be argued for on the basis of their worth and not on the basis of authority.
3. Systems are provided which utilize the above categories and processes for their analyses. For exa[illegible] when investigating the earth-sun system and in particular the process by which the earth maintains [illegible] energy balance (or radiative equilibrium) important categories are incoming light (or insolation), amount o[illegible] reflectivity and absorption, and resulting temperature. Hence, the student would be asked to investigate the system by alternately doing laboratory experiments to experience the categories and processes of light and energy and so on and then showing how they play out in the earth-sun system currently under study. In doing this, the student is encouraged to build on his/her everyday experience of climate (i.e., their everyday knowledge of the earth-sun system) to understand the category of radiation and its processes. Similarly, students are encouraged to use experience gathered in laboratory experiments of light, radiation, and temperature to understand the Earth-sun system. Hence, the focus becomes forging relations from categories and processes to systems.
4. These two-way relations are explicitly represented at some level of detail to aid students in making these connections. For example, relations might be provided for an analogous situation, say the energy budget of the human body, which too must balance its incoming energy (consumed in food, not light, energy) with its outgoing energy.
5. Diagnostic instruments are provided to help teachers identify what categories and processes students understand so as to help recommend activities for students to perform to persuade them of the utility of scientific concepts. For example, students who do not believe in the existence of infrared light could be shown it visibly though charge-coupled devices (CCD) calibrated to detect such light. Such a demonstration would show differential brightness over the surface of a human body, showing which areas were warmer and cooler. This acquaintance with a new category of infrared light could then be parlayed into the system of the earth-sun by examining visualizations of the infrared radiation emitted by the earth and relating it to the infrared radiation emitted by people.

There are several other areas to be developed that are not discussed here for reasons of space. These include a mentor data base, richly contextualized data sets, and tools for data analysis specialized for student use.

11. Conclusion

The WWW is in its infancy. As it grows and matures, many different communities will customize it and shape it to meet their specific needs. The K-12 teaching and learning community will be no exception. We have attempted to point out here that the needs of this community are diverse and that already the K-12 community has found resources on the WWW that are valuable. The demands of education are especially rigorous, particularly when we consider the development of both school-based and work-based learning communities. We have argued that there is a long way to go before the WWW can serve as a major tool for building educational communities. Specifically, the support for interactive communications is woefully underdeveloped, but it is receiving significant attention and growth. We have provided a progressive list detailing increasing depth in the formation of learning communities -- we urge architectural innovations for WWW interactive communications be evaluated with respect to this list. We hope that these suggestions will be used to spur thinking and development around customizing the WWW and its applications to meet the needs of schools and education more broadly.

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Footnotes

1 Of course, it can be said that all communities are "learning communities." Hence, implicit in distinctively labeling some communities as learning communities is a normative notion of what knowledge these communities should aspire towards. For example, in an ethnography of high school life, Eckert, (1989) found students primarily learning from one another, but almost none of this learning went beyond learning the social customs of high school culture. In contrast, within a learning community students engage in acquiring conceptual structures and explanatory systems useful to understand and transform their physical, social, and psychological world.

2 This term refers to increasing integration of computational processes with communication media. The primary characteristic of a computational communication medium is the ability not only to transmit and receive information, but also to specify the execution of complex procedures. Such integration has become commonplace not only in the Internet, but also in telephone systems through the introduction of automated interaction systems. In contrast, the term "computer-mediated communications" is much broader, encompassing not only CCTs but also any communication modality that utilizes computers whether or not it allows the embedding of complex procedures (e.g., e-mail or newsgroups).

3 As used here, a scientific visualization refers to an image rendered through high-speed computer graphics that is based on a numerical data set that describes some quantity in the world. For example, temperatures around the world can be rendered as a color image, typically mapping cold temperatures to blue hues and warmer temperatures to yellow and red hues.

4 The WWW can be considered interactive in that pages are retrieved in response to clicking on hypertext pointers. In contrast, we distinguish interactive communications to refer to dialogue, with the paradigmatic example being two people in conversation. Similarly embraced are epistolary exchanges such as found on newsgroups and email. This point is belabored here so as to avoid the conflation between clicking on hypertextual links and dialogue (Schank & Cleary, 1994). Dialogue, in contrast to clicking on hypertext links, is social and as such opens the possibility for negotiation of meaning and disagreement as well as the deepening of human relationships which form the obvious center of any learning community.

5 This is currently true, of course, only in principle, since access to the Internet is present in only a few schools. Hence, a priority for the education community and for the general body politic must be to ensure equity of access; else the learning communities we seek to build will be closed to segments of the population -- this inequity will injure not only the disenfranchised but will also diminish the quality and range of the learning communities we build by restricting the diversity of thought they possess.

Global Connections through Electronic Mail Systems

by Stephen W. Zsiray, Jr

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ED 367 325

Introduction

Today's students have a tremendous opportunity to tap into a global information highway that will transform the ways in which information is accessed, retrieved, and then utilized. Neil Postman (1992) asks the question: "What problem does the information solve?" The answer is usually "How to generate. store, and distribute more information, more conveniently, at greater speeds than ever before." This is the elevation of information to a metaphysical status: information as both the means and end of human creativity. In Technopoly, we are driven to fill our lives with the quest to "access" information.

The purpose of this paper is to provide an overview of E-mail systems and to identify curricular applications of common systems available to educators. There are many useful classroom applications of E-mail. A major benefit of a computer network in an educational setting is the access to E-mail systems (Koltnow, 1993).

What does E-mail provide?

- Easy communication – for text, numbers, and graphics.
- Nondisruptive message delivery – a requirement for busy administrators and teachers
- The ability to communicate with many people at once.
- The potential for communication beyond school and district boundaries.

E-mail will give teachers and students their first taste of the true power of information access through shared discussions of ideas and concepts with colleagues from around the globe.

What services are out there?

There are several excellent services that are well suited to K-12 schools. Davis (1993) and Saks (1993) provide excellent survey articles of the available online services. I will outline some of the services that teachers and administrators use in the Cache School district.

America Online
8619 Westwood Center Dr., No. 200
Vienna, Virginia 22182-2285
800-827-6364

The cost is a $9.95 monthly fee for five hours of service. Additional on-line time charges of $3.50 per hour are charged any time of the day or night. Five free hours of time are given for start-up of the service.

CompuServe
Membership sales, P.O. Box 20212
Columbus, Ohio 43220
800-848-8199

A flat fee of $8.95 per month is charged for 36 basic services (waived for first month of membership). Many alternate pricing structures are available, based upon modem speed and the types of forums and reference services that are accessed.

World Classroom
Global Learning Corporation
P.O. Box 201361
Arlington, Texas 76006

800-866-4452
Approximate costs are $195 per school per year. Some negotiation is possible. This service is designed to integrate electronic classroom activities into the classroom. The curriculum is designed for Science, Social Studies, and Language Arts Activities. In addition, there is a Newslink and Guest Speaker program. Previous guest speakers on the system have included: an American ship's captain, an Air Force information officer, German politicians, a Dutch windmill expert, and Russian educators and scientists. The relevancy and immediacy with which information can be accessed is a stimulating experience.

What hardware and software do I need?

Any IBM or compatible system or Macintosh system with the proper modem will work. I will describe some systems below:

Hardware

- IBM or compatible, mouse recommended
- Macintosh
- Modem: 1200, 2400, 9600, or 14,400 baud modem (higher numbers are faster, and the faster the better)

Software

- Microphone 11, Microsoft Works 3.0a, Pro Comm, PFS, First Choice, and many others are available. America On-line and Compuserve provide the user with software.

What about the Internet?

The Internet is a global network of networks, giving the user the capability to converse and share ideas with other users from anywhere in the world. Over four million individuals are plugged into Internet, and that number is increasing by 20% per month. If you need the answer to any question, it can be found somewhere in the world. The Internet is not a central repository of information like a huge public library. Instead it is a way to access global information resources (both electronic and human). The Internet weaves an electronic spider web which connects data, information, and people (Morris, 1993).

Three major Internet tools are: (1) E-mail, (2) Remote Login (telnet), and (3) File Transfer (ftp).

1. The E-mail component allows the user to communicate with other users by sending and receiving information. Private and public messages can be sent on the system. There are many newsgroups that share information and there are no membership fees. For example, middle school educators and students can access a service through Internet by sending to a Bitnet list server at UIUCVMD <listserv@vmd.cso.uiuc.edu>. Communications can be established with the middle school education community from around the nation and world.
2. Remote login allows the user to connect to a network or computer system in some remote location. Some examples are: Library of Congress, NASA computer (SPACELINK), U.S. Weather service (WEATHER UNDERGROUND), and many research libraries throughout the world.
3. File Transfer allows the user to obtain files from a remote network or computer system. Information such as magazine articles, research, and gaming software is accessible.

How do E-Mail systems help students?

Let's look at what E-mail systems could do to help the student. First, they can potentially help the student to develop a higher level of self-confidence.

> Since students cannot see each other as they communicate via computer modem, their usual pre-adolescent concerns about appearance, clothes, social status, and gender are set aside. Whether quiet or strident, the sound of their young voices does not matter. When participating in telecommunication activities, they are all on a level playing field. They are part of a global student body, removed from the isolation of their

> classroom by "traveling" great distances to acquire information first hand from their peers across the seas. The cultural insight gained through such "travels" enhances students' self-image as citizens of their country and gives them confidence in their ability to be good ambassadors. (Rosemary Lee Potter, 1992)

Second, the student will collect and use "real time" information that has been accessed in a simple, direct and relatively inexpensive manner. Whether it be through America Online, CompuServe, or Internet, teachers and students have the electronic key to open up a global network of information resources. These resources include fastbreaking stories from newspapers around the world; up-to-date international political and economic data; educational software that can be brought back to the classroom; libraries of information at major universities; and access to other students, teachers, specialists, legislators, to the Library of Congress, and even the White House (Dyrli, 1993). Is the sky the limit?... NO.

Third, students are discovering the interconnectedness of the world and the learning experiences extend beyond subject boundaries and school walls. In the process of finding, using, and analyzing information, students are forming meaningful relationships with their contemporaries from around the nation and world, attempting to communicate by asking the questions that will yield relevant information. Students are moving beyond the close confines of the classroom and school building to expand to a more global environment. The computer, modem, and phone line will extend the classroom to any "virtual" location. Paulsen (1987) defined the "virtual school" by stating:

> A virtual school is an information system able to handle all the tasks of a school without the basis of an existing physical school. A virtual school will thus not exist as a physical building containing classrooms, offices, teachers, staff and students. Nevertheless, it may be thought of as real, since it can assume all the responsibilities of an ordinary (physical) school. An alternative definition of the virtual school concept is that it is an extension of the traditional school, a notion that teachers, as orchestrators of instruction, now have the technological tools to extend the classroom to any "outside" environment, whether literally outside the physical school boundaries or through electronic extensions.

Curriculum Applications

I will describe an exercise that recently was experienced by students at Spring Creek Middle School, Providence, Utah and Mountain Crest High School, Hyrum, Utah. Our students have been communicating issues and ideas with students in Russia. A recent episode in Russian current events will be illustrated in the following section.

Russian Scenario or "Habituation can be deadly in the classroom."

Nancy Johnson (October 28, 1993) named the 3R's that schools need to teach students in order for them to be successful in the 21st Century. They are:

1. Find, use, analyze, and present information
2. Communicate effectively with each other
3. Form meaningful and work relationships with each other

Let's apply these 3R's in a recently completed exercise. We need to give learners a mosaic of opportunities by teaching them to think in different ways, ask different kinds of questions, and apply what they know in different ways. E-mail systems can bring all of these elements together to create building blocks in the critical thinking process. In this exercise, we will consider the following scenario which applies to the recent situation in the Russian Republic and the events which led up to the ill-fated coup.

How does the student find, use, analyze, and present information? Traditionally, the middle school student would go to the library media center and find a newspaper that may have a piece of information on the topic, look over *Time* magazine to find any background information that may apply to the events that took place prior to the coup, and perhaps access a print or electronic version of an encyclopedia for background information about the country. In essence, the student is finding, using, and analyzing third party stuff. What can telecommunications do to help the student find information? Please refer to *Figure 1*. Today a student can access information from a myriad of online resources. Each of the previously mentioned services will yield information: America Online, CompuServe, World Classroom and Internet. Using online systems gives the student, first person, "real time" information collected in a simple, direct and relatively inexpensive manner.

Other Curricular Applications

Electronic mail applications span the curriculum. Additional applications cover many curricular areas (Wishnietsky (1991) and Martinelli-Zaun (1993)).

Mathematics

Some new elements of the NCTM Standards emphasize statistics, data collection and analysis, and probability. Students in schools in different parts of the country could research the cost of items in their community and then compile and report the results. How much is a loaf of bread, six pack of Coke, half-gallon of milk (convert to liters) and a dozen eggs in Logan, Utah; Steubenville, Ohio; and Troitsk, Russia? Varied charts and graphs can then be produced. Data can be used to depict the popularity of issues and leaders. Recently, the results of a poll was presented to students in Providence, Utah by some Muscovite students. It stated that the citizens of Moscow favored Yeltsin by 56%, Rutskoe 15%, Kharbulativ 4%, none of them 20% and don't know 5%. How popular is Boris Yeltsin in Providence? Or Bill Clinton in Moscow?

Language Arts

Pen pal systems are established and treat a variety of issues and relevant topics of the day. Students from around the world ask, and receive answers to, questions that are generated by the inquisitive minds of middle school students. Why was there a revolt in Russia? How many tulips are produced in the Netherlands and shipped to the U.S. each year? How do you feel about the oil spill off the northern coast of England? These and many other questions pique the interest of students on a daily basis.

Science

Weather is a subject that seems to be of interest to young and old alike. When all else fails, bring up the topic of weather in a conversation. Statistical concepts are most easily learned when climatological data are used to teach them. Also, the topic of environmental science is very often a catalyst that can be used to spark international conversation. What about the ozone layer?

Social Studies

Through electronic dialog and then analysis, students will discover similarities and contrasts between historical events in the regions of the world and how these events have had an impact on the development of countries, as well as current foreign policy. Compare and contrast the American Revolution of 1776 with the Bolshevik Revolution of 1917, the Hungarian Revolution of 1956, and the Russian Coups of 1991 and 1993.

Foreign Language

What better way to learn a foreign language than to be taught by a native speaker? Students are now working with students in Russia to learn the basic conversational elements of the language. In addition, cultural diversity can be studied through the development of travelogues of different countries.

Desk Top Publishing - (integrating subjects across the curriculum)

Information collected can be shared and discussed via E-mail, compiled and then desktop published as a book. Students love to bring home the finished product. One such project could include the following components:

Famous People

Students research famous people from their area and collect information for purposes of identifying individuals who would be willing to share and answer questions posed by students from around the world. A list of names could be compiled and students could then identify, contact, and assemble the information, thus creating a living biography of famous folks representing various regions of the globe. Historical Perspectives Information is collected on historical events that shaped the development of the area in which they live. Text and graphics can be combined to produce a history book which will expand in size as students compile, digest, and then publish updated versions. With textbook companies, we wait for the new edition, which may take years to produce. Student 'new editions' may be published on a weekly basis.

Class Novel

Students weave combinations of characters and landmarks from their community to generate an historical novel.

Week in the Life of...

A journal for the week is presented, which details the activities that took place at the middle school, or at home.

Travel Brochure

Students put together a travel brochure which briefly describes interesting sites, local weather, holidays, etc. Services such as CompuServe provide software that allow graphic images to be downloaded and then pasted into documents.

Desktop publishing applications are endless, limited only by the creativity of students and teachers.

Some Concluding Thoughts

A new textbook is emerging. How is the textbook changing and what will it become? What teaching challenges and learning opportunities can we expect with the change? And how will we pay for it? These and many other questions arise. E-mail access and desktop publishing by school systems will change the way in which information is collected, analyzed, and delivered to the learner. Information will no longer simply be collected by the textbook publisher and their team of writers, organized, and then printed in the form of the traditional textbook. Tomorrow's textbook (next week, maybe now) will be developed by students, teachers, parents, and administrators. Each school site will build, through electronic means, instructional materials to meet the needs of the learner. Telecommunications systems will connect a world community of learners. We have some creative times in store. Educational communities of students, teachers, parents, administrators, and businesses will work together to devise new relevant systems of learning. These systems will expand beyond the physical limitations of the school building. In other words, welcome to the virtual school.

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An Introduction to Internet Resources for K-12 Educators. Part I: Information Resources.

Nancy A.Morgan,
ERIC Clearinghouse on Information and Technology, Syracuse, NY.

ERIC Digest. ED372757, May 94.
THIS DIGEST WAS CREATED BY ERIC, THE EDUCATIONAL RESOURCES INFORMATION CENTER.
FOR MORE INFORMATION ABOUT ERIC, CONTACT ACCESS ERIC 1-800-LET-ERIC

The Internet is an international computer network consisting of thousands of smaller interconnected computer networks. In the field of education, colleges and universities have been connected to the Internet for several years. Recently, state and regional education networks for the K-12 community have been springing up all over the United States, making the vast resources of the Internet readily available to classroom teachers. This digest outlines some of the rich resources that are available without cost to K-12 educators over the Internet computer network.

Readers should be aware that the Internet is an ever changing entity, and that the resources and their Internet addresses below are subject to change.

GUIDES TO INTERNET RESOURCES:

Clearinghouse of Subject-Oriented Internet Resource Guides: A large collection of guides to Internet resources categorized by topic. Address: gopher una.hh.lib.umich.edu

LESSON PLANS:

The AskERIC Virtual Library contains hundreds of lesson plans, including, but not limited to, language arts, mathematics, social studies, and science. Also included are the electronic versions of CNN Newsroom Classroom Guides and Discovery Education Online. Address: gopher ericir.syr.edu; or telnet ericir.syr.edu, login as "gopher"

KEYPALS AND PENPALS:

Students can learn about other cultures, geographic regions, and current events from their peers by corresponding with them by electronic mail. For instance, students studying a foreign language can correspond directly with students from another country over the Internet, practicing their written and reading language skills, while obtaining information about the culture and everyday lives directly from their peers in the other country.

- The Oklahoma Geological Survey Observatory gopher has a large collection of messages from K-12 students looking for keypals. Address: gopher wealaka.okgeosurvey1.gov

IECC - Intercultural Email Classroom Connections maintains three listservs that serve to facilitate international and cross-cultural classroom exchanges via email over the Internet.

1. IECC@STOLAF.EDU: is a listserv which serves as a "meeting place" for classroom partners to connect for international and cross-cultural exchange. It is not intended for individuals seeking penpals. To subscribe: send a message containing the word "subscribe" to iecc-request@stolaf.edu

2. IECC-PROJECTS@STOLAF.EDU: is a listserv where people may announce projects or request help with projects that involve international or cross-cultural email exchanges. To subscribe: send a message containing the word "subscribe" to iecc-projects-request@stolaf.edu

3. IECC-DISCUSSION@STOLAF.EDU: is a listserv for general discussion of questions, issues, and observations of the Intercultural Email Classroom Exchange. To subscribe: send a message containing the word "subscribe" to iecc-discussion-request@stolaf.edu

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ACCEPTABLE USE POLICIES:

Appropriate use of the Internet by teachers and students is a concern of many educators. Conduct on the part of the user, such as the use of abusive language or profanity, respect for copyright and licensing agreements, or the use of the network by minors for the purpose of obtaining pornography, for example, may not be considered acceptable use of the Internet. Samples of agreements and policies outlining the responsibilities and privileges of users have been collected at Armadillo: The Texas Studies Gopher. Address: gopher riceinfo.rice.edu 1170

TECHNOLOGY PLANS FOR K-12 SCHOOLS:

The National Center for Technology Planning collects technology plans submitted by schools and makes them freely available over the Internet. Other documents that are available include planning aids such as checklists, planning forms, and electronic monographs. Address: gopher ra.msstate.edu; or ftp ra.msstate.edu; directory is /pub/archives/nctp

INTERNET PROJECTS FOR THE CLASSROOM:

A question that many teachers have is: How can use of the Internet be incorporated in the classroom? Examples of telecommunication projects can be found on the:

- CICNet K-12 Gopher: This gopher has a collection of classroom projects that incorporate use of the Internet into the classroom. Address: gopher gopher.cic.net 3005

- Umass K-12 Gopher: Several telecommunication projects are listed, including guidelines from the Global SchoolNet to help teachers plan a successful project. Address: gopher k12.ucs.umass.edu

GRANT INFORMATION:

U.S. Department of Education: A Teacher's Guide to the U.S. Department of Education, found on the U.S. Department of Education gopher, describes programs, services, and publications, including educational grants provided by the U.S. Department of Education. This guide briefly describes the grant programs that are relevant to teachers and the offices that manage them. It also lists telephone numbers you can call with specific questions in these areas. Address: gopher gopher.ed.gov

GOVERNMENT INFORMATION:

The number of Internet sites that provide federal government documents and resources is continually increasing. Two examples are:

- Library of Congress Marvel: Includes Congressional, White House, and State Department information and documents and more. Address: gopher marvel.loc.gov

- Internet Wiretap: White House Press Releases (updated daily), laws, treaties, and other assorted legal and historical documents. Address: gopher wiretap.spies.com

STATE EDUCATION DEPARTMENTS:

This is a partial list of Internet sitess run by state departments of education:

- Michigan Department of Education: Provides direct access to several K-12 gophers, State Board of Education approved curriculum goals and objectives, and links to several free-nets. Address: gopher.mde.state.mi.us

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- California Department of Education: Provides up to date information, including selective legislative and California State Board of Education information, education conferences, a technology planning guide for California schools, and the Bilingual Education Network (BiEN). Address: gopher goldmine.cde.ca.gov

- New York State Education Department: Provides up to date Internet and telecommunication news that is of interest to the K-12 community. Address: gopher unix5.nysed.gov

ELECTRONIC BOOKS:

Project Gutenberg: Classic, religious and children's books, poetry, and historical documents in full text. Address: gopher joeboy.micro.umn.edu; or ftp deneva.sdd.trw.com (then cd pub/etext), login as "anonymous", password is your Internet address.

REFERENCE RESOURCES:

Florida Tech Education Gopher: Access to a nice collection of reference sources including the American English Dictionary, Roget's Thesaurus, the U.S. Zip Code Directory, telephone area code directories for the United States and foreign countries, and 1990 U.S. Census Information. Also included is the CIA World Fact Book, which contains geographic, climatic, economic, and political information about every country and territory in the world. Address: gopher sci-ed.fit.edu 70

LIBRARY CATALOGS:

Yale University provides easy access to worldwide library catalogs. Users can browse through a geographic listing, or search by institution, library name or city. Helpful instructions, organized by catalog vendor, are also provided. Address: gopher yaleinfo.yale.edu 7000

Library of Congress Information System: Provides access, not only to the holdings of the Library of Congress, but also to U.S. government copyright files, federal legislation, and foreign law. Address: telnet locis.loc.gov

WORLD WIDE WEB SITES:

The World Wide Web (WWW) provides access to Internet documents in hypertext and multimedia by using advanced WWW clients such as NCSA's Mosaic. Some WWW sites with information especially useful for educators are:

- AskERIC Virtual Library Address: HTTP://eryx.syr.edu

- U.S. Department of Education Address: HTTP://www.ed.gov

- TERC Science and Math Education Address: HTTP://hub.terc.edu

OTHER RESOURCES:

Hundreds of resources covering almost every subject imaginable exist on the Internet. Here are some additional ones that would be of special interest to K-12 educators:

- Consortium for School Networking (CoSN): Provides access to information about several education projects on the Internet and Internet training materials. Address: gopher cosn.org 70; telnet cosn.org, login as "gopher" (no password)

- Empire State Schoolhouse: Specially designed for the novice user, the Empire State Schoolhouse provides many resources of interest to the K-12 educator. Reference resources, Internet projects, and information on school reform and technology planning are some of the resources that are available. Address: gopher nysernet.org 70;

- California Department of Education: Provides up to date information, including selective legislative and California State Board of Education information, education conferences, a technology planning guide for California schools, and the Bilingual Education Network (BiEN). Address: gopher goldmine.cde.ca.gov
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LIBRARY CATALOGS:

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Library of Congress Information System: Provides access, not only to the holdings of the Library of Congress, but also to U.S. government copyright files, federal legislation, and foreign law. Address: telnet locis.loc.gov

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login as "empire" (no password)

- ERIC Clearinghouse on Assessment and Evaluation: Information on assessment for all levels of education. Also provides several access points to the ERIC database. Address: gopher vmsgopher.cua.edu

- ERIC Clearinghouse for Science, Mathematics and Environmental Education: Information for math and science educators. Address: gopher gopher.ericse.ohio-state.edu

- NASA Spacelink: Information about NASA, including the space shuttle program, science curriculum activities. Address: telnet spacelink.msfc.nasa.gov, login as "newuser", password "newuser"

- Ohio Education Computer Network: This gopher is designed for use by K-12 students. Address: gopher nwoca.7.nwoca.ohio.gov

Part II: Question Answering, Listservs, Discussion Groups.

QUESTION ANSWERING:

The number of information services that use electronic mail to deliver information is increasing. Services that teachers will find on the Internet include:

AskERIC: AskERIC is a human mediated question answering service for teachers, library media specialists, administrators, and others involved in education. A project of the ERIC Clearinghouse on Information and Technology at Syracuse University, AskERIC uses the vast resources of the ERIC system and the Internet to answer questions sent by electronic mail. Questioners receive an electronic mail response at no cost within 48 hours. Typical responses include citations from ERIC database searches, full text ERIC Digests, and Internet resources such as listservs and addresses for gopher sites. (Frequently asked questions (FAQs) and other resources developed from questions received at AskERIC are archived at the AskERIC Virtual Library which can be accessed by gophering to askeric@ericir.syr.edu) Address for electronic mail questions: askeric@ericir.syr.edu

Ask a Young Scientist: A question answering service for elementary students on scientific topics. Questions are researched and answered by advanced chemistry students. Students are asked to limit their questions to five per message, but are encouraged to post as many questions as they wish. Address: apscichs@radford.vak12ed.edu

Ask Prof. Math: Answers questions on mathematical content or pedagogy from K-8 students and teachers. (Archives of the questions and responses can be found via anonymous ftp atacs.sbu.edu in the pub/prof.math subdirectory.) Address: maths@sbu.edu Online Writing Lab

(OWL): Purdue University Writing Lab provides help on correct English usage and writing. Information on how to get free copies of help sheets on topics ranging from resume writing to proper punctuation can be obtained by sending a message to owl@sage.cc.purdue.edu. Subject: owl-request. Message: Send help. Tutors will also answer a question by email. Send the question to owl@sage.cc.purdue.edu.

LISTSERVS:

Listservs are automated programs that serve as distribution centers for mail messages. Listservs usually focus on a single topic that may be very broad or extremely narrow. People join a listserv by subscribing, and actively participate by sending messages to the listserv, or by simply reading them.

To subscribe, send a message to: listserv@node Leave the subject line blank. In the body of the message, write: subscribe <listserv@node> <your firstname lastname>

For example, to subscribe to LMunderscoreNET: Address the message to: listserv@suvm.syr.edu. Message: subscribe LMunderscoreNET Nancy Morgan

Below are listservs of special interest to K-12 educators:

NET-HAPPENINGS@is.internic.net: Internet related news and announcements login as "empire" (no password)

- ERIC Clearinghouse on Assessment and Evaluation: Information on assessment for all levels of education. Also provides several access points to the ERIC database. Address: gopher vmsgopher.cua.edu

- ERIC Clearinghouse for Science, Mathematics and Environmental Education: Information for math and science educators. Address: gopher gopher.ericse.ohio-state.edu

- NASA Spacelink: Information about NASA, including the space shuttle program, science curriculum activities. Address: telnet spacelink.msfc.nasa.gov, login as "newuser", password "newuser"

- Ohio Education Computer Network: This gopher is designed for use by K-12 students. Address: gopher nwoca.7.nwoca.ohio.gov

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Ask a Young Scientist: A question answering service for elementary students on scientific topics. Questions are researched and answered by advanced chemistry students. Students are asked to limit their questions to five per message, but are encouraged to post as many questions as they wish. Address: apscichs@radford.vak12ed.edu

Ask Prof. Math: Answers questions on mathematical content or pedagogy from K-8 students and teachers. (Archives of the questions and responses can be found via anonymous ftp atacs.sbu.edu in the pub/prof.math subdirectory.) Address: maths@sbu.edu Online Writing Lab

(OWL): Purdue University Writing Lab provides help on correct English usage and writing. Information on how to get free copies of help sheets on topics ranging from resume writing to proper punctuation can be obtained by sending a message to owl@sage.cc.purdue.edu. Subject: owl-request. Message: Send help. Tutors will also answer a question by email. Send the question to owl@sage.cc.purdue.edu.

LISTSERVS:

Listservs are automated programs that serve as distribution centers for mail messages. Listservs usually focus on a single topic that may be very broad or extremely narrow. People join a listserv by subscribing, and actively participate by sending messages to the listserv, or by simply reading them.

To subscribe, send a message to: listserv@node Leave the subject line blank. In the body of the message, write: subscribe <listserv@node> <your firstname lastname>

For example, to subscribe to LMunderscoreNET: Address the message to: listserv@suvm.syr.edu. Message: subscribe LMunderscoreNET Nancy Morgan

Below are listservs of special interest to K-12 educators:

NET-HAPPENINGS@is.internic.net: Internet related news and announcements

CHILDLIT@RUTVM1.RUTGERS.EDU: Children's literature

LMunderscoreNET@suvm.syr.edu: School library/media services

SUPERK12@suvm.syr.edu: Supercomputing implementation and utilization in the K-12 environment

K12ADMIN@suvm.syr.edu: K-12 educational administration

MIDDLE-L@VMD.CSO.UIUC.EDU: Middle school education

EDNET@nic.umass.edu: Internet use in education

EDTECH@MSU.BITNET: Educational technology

EDPOLYAN@ASUVM.INRE.ASU.EDU: Education policy

KIDSPHERE-request@vms.cis.pitt.edu: Global network (formerly Kidsnet) for K-12 children & teachers

KIDLINK@vm1.nodak.edu: Kidlink Society runs several listservs in support of a global dialog for 10-15 year old students. Subscribe to KIDLINK listserv to receive information about the other lists.

ECENET-L@VMD.CSO.UIUC.EDU: Early childhood education

TESLK-12@CUNYVM.CUNY.EDU: Teachers of English as a second or foreign language to children

ICN-REQUEST@ctrvax.vanderbilt.edu: International Counselor Network (ICN): counselors or counselor educators

BIOPI-L@ksuvm.bitnet: Secondary education relating to biology

NEWEDU-L@uscvm.bitnet: New and improved methods of education

TAG-L@avml.nodak.edu: Talented and gifted students

MUSIC-ED@UMINN1.Bitnet: Music education

USENET NEWSGROUPS:

Usenet Newsgroups are an electronic bulletin board system, accessible via the Internet, that consists of discussion forums on literally thousands of topics. Users should contact their system operator for instructions. (Student access should be monitored. Many newsgroup topics are not suitable for minors.)

Some of the Usenet Newsgroups are:

k12.chat.elementary: General discussion for Elementary Students

k12.chat.junior: General discussion for Junior High Students

k12.chat.senior: General discussion for Senior High Students

k12.chat.teacher: General discussion between K12 Teachers

k12.ed.art: Arts and Crafts Education

k12.ed.business: Business Education

k12.ed.life-skills: Life Skills Education

k12.ed.math: Mathematics Education

k12.ed.music: Music and Performing Arts

k12.ed.science: Science Education

CHILDLIT@RUTVM1.RUTGERS.EDU: Children's literature

LMunderscoreNET@suvm.syr.edu: School library/media services

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EDTECH@MSU.BITNET: Educational technology

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k12.ed.life-skills: Life Skills Education

k12.ed.math: Mathematics Education

k12.ed.music: Music and Performing Arts

k12.ed.science: Science Education

k12.ed.soc-studies: Social Studies Education

k12.ed.tag: Talented and Gifted Education

k12.ed.tech: Technology Education

REFERENCES AND READINGS

Abbott, T. (Ed.). (1994). INTERNET WORLD'S ON INTERNET94: AN INTERNATIONAL GUIDE TO ELECTRONIC JOURNALS, NEWSLETTERS, TEXTS, DISCUSSION LISTS, AND OTHER RESOURCES ON THE INTERNET. Westport, CT: Mecklermedia. (ISBN: 0-88736-929-4)

Andres, Y. M. (1993). Education on-line. EXECUTIVE EDUCATOR, 15(6) 21-23.

Harris, J. (1993). Mining the Internet: Using Internet know- how to plan how students will know. COMPUTING TEACHER, 20(8), 35-40.

K-12 computer networking. (1993). THE ERIC REVIEW, 2(3). (ED 355 940)

Krol. E. (1992). THE WHOLE INTERNET: USER'S GUIDE & CATALOG. Sebastopol, CA: O'Reilly. (ISBN: 1-56592-025-2)

Murray, J. (1993). K12 network: Global education through telecommunications. COMMUNICATIONS OF THE ACM, 36(8), 36-41.

Sellers, J. (1994). FYI ON QUESTIONS AND ANSWERS: ANSWERS TO COMMONLY ASKED 'PRIMARY AND SECONDARY SCHOOL INTERNET USER' QUESTIONS. Network Working Group, Request for Comments 1578. Available from AskERIC Virtual Library, gopher ericir.syr.edu

Tennant, R. (October, 1992). INTERNET BASICS. ERIC DIGEST. Syracuse, NY: ERIC Clearinghouse on Information & Technology. (ED 348 054)

Valauskas, E. J. (1993). Education online: interactive K-12 computing. ONLINE, 17(4), 89-91.

Nancy A. Morgan is AskERIC Coordinator for the ERIC Clearinghouse on Information & Technology.

BIBLIOGRAPHY

Selected Abstracts from the ERIC Educational Resources Database

ERIC Clearinghouse on
Reading, English, and Communication
Indiana University
Bloomington, Indiana

How to Read an ERIC Abstract and Find Related Articles on this Subject

The ERIC educational resource database includes more than 800,000 bibliographic records. Educational resources listed in the ERIC database are of two types: EJ, journal (magazine) articles, which are easily found in most Education libraries, or through interlibrary loan; and ED, documents such as Master's theses, which are available at any library that has an ERIC microfiche collection. ED documents can also be ordered directly from ERIC Document Reproduction Service by using the form at the end of this bibliography section.

You may also wish to perform your own ERIC database search, to retrieve the most current information on your topic. This is easily done at any Education library; it may also be available to you online through your university computing system.

In the following bibliography, we have selected some recent relevant articles that you may wish to read for your further knowledge, or to use in a Distance Education Application/Research Project. ERIC abstracts are easy to read, once you are used to the system, which is detailed below.

Sample ERIC Abstract

Note that this abstract has an EJ accession number, which means that the work abstracted is a journal article.

ERIC Accession Number—identification number sequentially assigned to articles as they are processed.	EJ466919 EC606287	**Clearinghouse Accession Number**
Article Title	**Family-Centered Techniques: Integrating Enablement into the IFSP Process.** Andrews,	
Author(s)	Mary A.; Andrews, James R. *Journal of Childhood*	**Journal Title**
	Communication Disorders, v15 n1 p41-46 1993	**Volume No., Issue No., Pages Publicaton Date**
Reprint Availability	(Reprint: UMI)	
Descriptive Note	Note: Theme Issue: Service Delivery to Infants and Toddlers: Current Perspectives.	
	ISSN: 0735-3170	**ISSN** (International Standard Serial Number)
Major and Minor Descriptors—subject terms found in the *Thesaurus of ERIC Descriptors* that characterize substantive content. Only the major terms (preceded by an asterisk) are printed in the Subject Index of *Current Index to Journals in Education (CIJE)*	Descriptors: Child Rearing; *Communication Disorders; *Early Intervention; *Family Involvement; Individual Development; Objectives; Parenting Skills; Skill Development; *Teamwork; Young Children	
	Identifiers: *Enabler Model; Family Needs; *Individualized Family Service Plans	**Major and Minor Identifiers**—terms found in the *Identifier Authority List* that characterize proper names or concepts not yet represented by descriptors. Only the major terms (preceded by an asterisk) are printed in the Subject Index of *Current Index to Journals in Education*
Annotation	This article describes techniques, used in a family-centered early intervention project, that both assist in accomplishing the goals of the individualized Family Service Plan process and create opportunities for families to display their present competencies and acquire new ones to meet the needs of their children with communication disorders.	
Annotator's Initials	(Author/JDD)	

Note: The format of an ERIC Journal Article resume will vary according to the source from which the database is accessed. The above format is from the printed index, *Current Index to Journals in Education*.

1/95

The Following Abstracts are From the ERIC Educational Resources Database

AN: EJ497929
AU: Ross,-Patricia
TI: **Relevant Telecomputing Activities.**
PY: 1995
JN: Computing-Teacher; v22 n5 p28-30 Feb 1995
AV: UMI
AB: Discusses the use of telecomputing in classrooms. Topics include telecomputing goals; use of the Internet; language arts and music FTP (file transfer protocol) sites; social studies FTP sites; science Telnet sites; social studies Telnet sites; skill building and learning processes; and instructional design. (LRW)

AN: ED378577
AU: Monahan,-Brian-D.
TI: **The Internet in English Language Arts.**
PY: 1994
NT: 15 p.; Paper presented at the Annual Meeting of the National Council of Teachers of English (84th, Orlando, FL, November 16-21, 1994).
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: A recent article in the "Assemby for Computers in English (ACE) Newsletter" explains what most instructors of English already know--that students in most writing classes produce papers for which the primary purpose is the teacher. As the Internet becomes more widely available, students will have more access to what Howard Rheingold calls the "living database." Michael Day suggests that students can monitor discussion groups and determine the purpose and audience for which the group exists and then post messages to these groups. This activity gives students the opportunity to write for real purposes and real audiences. One recent item found on the Empire Internet schoolhouse might be of special interest to teachers of writing. The exercise is called "The Doomed Train." Its purpose is to give students experience in writing persuasive papers. Students get this experience by writing a paper and then a rebuttal to a student on the Internet who has an opposite view. There are any number of other opportunities whereby teachers can use Internet or e-mail to enhance the writing experiences of their students--word-processing is no longer the cutting edge in technology for the writing classroom. For instance, students can do research on the Internet. Also, creative writers can access CREWRT-L, a place where they can send their work to be critiqued. (Contains 12 references.) (TB)

AN: ED375822
AU: Miller,-Elizabeth-B.
TI: **The Internet Resource Directory for K-12 Teachers and Librarians, 94/95 Edition.**
PY: 1994
AV: Libraries Unlimited, Inc., P.O. Box 6633, Englewood, CO 80155-6633 ($25).
NT: 212 p.; This directory will be published annually.
PR: Document Not Available from EDRS.
AB: Designed for educators who are beginning to explore the Internet, this guide designates sites of interest for K-12 education and describes how to access them. The importance and benefits of Internet access for K-12 schools are discussed in the opening chapters. Guidelines and tips for getting started are offered and scenarios of how teachers and librarians are currently using the Internet are described. The remainder of the book lists resources in the subject areas of art, music, and drama; foreign languages; language arts; math and computer sciences; science; social studies and geography; and reference. In each subject category, resources are listed by name with their current Internet addresses; if the name is not self-explanatory, a brief annotation is provided. There are also separate chapters on resources specifically for educators and for library media specialists. Resources listed include gopher sites; national, state and regional networks; electronic periodicals and books; discussion groups; archives; and organizations offering question answering services. A bibliography, a history of the Internet, and an index are also included. (JLB)

AN: ED367325
AU: Zsiray,-Stephen-W., Jr.
TI: **Global Connections through Electronic Mail Networks.**
PY: 1993
NT: 14 p.; Paper presented at the Annual Conference of the National Middle School Association (20th, Portland, OR, November 4-7, 1993).
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: This paper provides an overview of electronic mail (e-mail) systems and identifies curricular applications of common systems available to educators. Highlights include an outline of selected e-mail services; a description of hardware and software needed to use e-mail; an introduction to the Internet; a look at how e-mail systems help students; and some curriculum applications, including mathematics, language arts, science, social studies, foreign languages, and desktop publishing. (Contains 12 references.) (JLB)

AN: ED366981
AU: Homme,-John, Comp.; And-Others
TI: **A Guide to Internet Resources in Language Arts.**
PY: 1994
NT: 24 p.; Paper presented at the Annual Conference of the Association for Supervision and Curriculum Development (Chicago, IL, March 19-22, 1994).
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: This paper presents a list of 154 Internet resources (listservs, freenets, telnet sites, gophers, etc.) dealing with language arts. Each entry in the list includes the name of the resource, and subscription and electronic mail addresses. Some of the entries in the list include a brief description of the resource. The paper lists 17 language arts listservs, 10 freenets with language arts resources, 32 telnet sites with language arts resources, 17 ftp sites for language arts teachers, 15 language arts gophers, 8 useful frequently asked questions (FAQ's) for language arts teachers, 49 news groups related to language arts, and 6 commercial services

dealing with language arts available via the Internet. (RS)

AN: EJ488764
AU: Cutler-Landsman,-Donna; Wrzesinski,-Conrad-J.
TI: **Internet: A Vehicle for Original Student Research.**
PY: 1994
JN: Teaching-and-Change; v1 n2 p135-53 Win 1994
AB: The study described in this article investigated original student research using student-to-student telecommunications. Sixth graders gathered original data through Internet to answer their own questions about education in other countries. Student surveys and teacher observation indicated students found telecommunications highly motivating. (SM)

AN: EJ488303
AU: Silva,-Marcos; Breuleux,-Alain
TI: **The Use of Participatory Design in the Implementation of Internet-Based Collaborative Learning Activities in K-12 Classrooms.**
PY: 1994
JN: Interpersonal-Computing-and-Technology-Journal; v2 n3 p99-128 Jul 1994
NT: To retrieve this article, send the following e-mail message to LISTSERV [at sign] GUVM.GEORGETOWN.EDU: GET SILVA IPCTV2N3.
AB: Discusses research on the process of introducing telecommunication technology in K-12 classrooms. To ensure parent and teacher involvement in Internet-based collaborative learning projects, a participatory design approach is examined that allows teachers to monitor and influence project design. This approach is selected because of its effectiveness in industry. (Contains 80 references.) (Author/KRN)

AN: EJ487763
AU: Bailey,-Elaine-K.; Cotler,-Morton
TI: **Teaching via the Internet.**
PY: 1994
JN: Communication-Education; v43 n2 p184-93 Apr 1994
AV: UMI
NT: Special Issue on the Internet--The National Information Infrastructure.
AB: Discusses some techniques and methodologies used in efforts to integrate computers and communication technology into existing curricula. Discusses teacher-student interaction, student-student interaction, electronic guest lecturers, and electronic forums and panels. (SR)

AN: EJ485259
AU: Maule,-R.-William
TI: **The Network Classroom.**
PY: 1993
JN: Interpersonal-Computing-and-Technology-Journal; v1 n1 Jan 1993
NT: To retrieve this article, send the following e-mail message to LISTSERV [at sign] GUVM.GEORGETOWN.EDU: GET MAULE IPCTV1N1 F=MAIL.
AB: Discussion of the role of new computer communications technologies in education focuses on modern networking systems, including fiber distributed data interface and Integrated Services Digital Network; strategies for implementing networked-based communication; and public online information resources for the classroom, including Bitnet, Internet, USENET, LISTSERVs, automated libraries, and government information. (Contains 50 references.) (LRW)

AN: EJ483747
AU: Barron,-Daniel-D.
TI: **School Library Media Specialists and the Internet: Road Kill or Road Warriors?**
PY: 1994
JN: School-Library-Media-Activities-Monthly; v10 n9 p48-50 May 1994
AB: Discusses use of the Internet by school library media specialists and its importance in the development of the library profession. Highlights include how to access the Internet and resources about the Internet, including information about networks as well as three sources that provide introductions to the general concepts of the Internet. (LRW)

AN: EJ483712
AU: Harris,-Judi
TI: **"Opportunities in Work Clothes": Online Problem-Solving Project Structures.**
PY: 1994
JN: Computing-Teacher; v21 n7 p52-55 Apr 1994
AV: UMI
AB: Provides activity structures for and gives examples of problem-solving projects to be used with educational telecomputing. Highlights include information searches, electronic process writing, sequential creations, parallel problem solving, simulations, social action projects, and instructions for accessing information about these and other projects through the Internet. (LRW)

AN: EJ483710
AU: Kelly,-M.-G.; Wiebe,-James-H.
TI: **Telecommunications, Data Gathering, and Problem Solving.**
PY: 1994
JN: Computing-Teacher; v21 n7 p23-26 Apr 1994
AV: UMI
AB: Discusses the use of telecommunications in elementary and secondary education and gives examples of classroom activities relating to math and science that use online services such as America Online, CompuServe, and Prodigy; electronic bulletin boards; educational computer networks; electronic mail; and listservs from the Internet. (Contains two references.) (LRW)

AN: EJ483691
AU: Fishman,-Barry-J.; Pea,-Roy-D.
TI: **The Internetworked School: A Policy for the Future.**
PY: 1994
JN: TECHNOS; v3 n1 p22-26 Spr 1994
AB: Discussion of elementary and secondary school classrooms linking with the Internet focuses on policies needed for successful use of the network. A project conducted at Northwestern University (Illinois) for reconceptualizing high school science

education is described, and development of a network use policy is examined. (LRW)

AN: EJ480183
AU: Kelly,-M.-G.; Wiebe,-James-H.
TI: **Teaching Mathematics with Technology: Mining Mathematics on the Internet.**
PY: 1994
JN: Arithmetic-Teacher; v41 n5 p276-81 Jan 1994
AV: UMI
AB: The Internet provides a resource accessible to students for solving problems and satisfying information needs. Describes how students can use e-mail and the NASA Spacelink, Geographic Name Server, and Weather Underground databases. Appendices provide internet addresses and selected state telecommunications networks. Sample student inquiries are provided. (MDH)

AN: EJ477971
AU: Burleigh,-Mike; Weeg,-Patti
TI: **KIDLINK: A Challenging and Safe Place for Children across the World.**
PY: 1993
JN: Information-Development; v9 n3 p147-57 Sep 1993
AB: Describes the activities of KIDLINK, an international electronic conferencing system that was developed to establish communication between children 10 to 15 years old around the world using the Internet and other computer networks. A list of local KIDLINK contacts in 29 countries is included. (LRW)

AN: EJ477954
AU: Germain,-Jack-M.
TI: **ERIC Goes Internet.**
PY: 1994
JN: Online-Access; v9 n1 p50-52,54,58-60 Jan-Feb 1994
AV: UMI
AB: Description of the ERIC database covers suggested uses for teachers, students, parents, and researchers; information available in ERIC; how to access ERIC, including through the Internet; the AskERIC service that is available through the Internet; and steps for searching the database. A directory of ERIC clearinghouses is also included. (LRW)

AN: EJ477941
AU: Jacobson,-Robert-L.
TI: **Connecting the Schools.**
PY: 1994
JN: Chronicle-of-Higher-Education; v40 n22 pA17-18 Feb 2 1994
AV: UMI
AB: Many colleges and universities are making their Internet computer links available to elementary and secondary schools, often free of charge. However, the assistance is still limited, and more teacher training, technical assistance, and appropriate equipment are needed. Examples in Florida, Virginia, Texas, and Illinois are offered. (MSE)

AN: EJ476325
AU: Mellon,-Constance-A.
TI: **Reflections on Technology, Books, and Children.**
PY: 1994
JN: Journal-of-Youth-Services-in-Libraries; v7 n2 p207-10 Win 1994
AV: UMI
AB: Considers possible influences of technology on children and children's literature. Topics discussed include the Internet; multimedia picture books; storytelling; and the personal relationship involved when children and adults are reading together that may not be replicated with technology. (LRW)

AN: EJ474999
AU: Blau,-Andrew
TI: **K-12 Access to Internet: Securing the Legal Framework.**
PY: 1993
JN: Journal-of-Science-Education-and-Technology; v2 n3 p497-503 Sep 1993
AB: Discusses legal issues that may arise as schools begin to provide internet access to K-12 students. A key concern is that students may be exposed to material that parents or teachers find inappropriate. (PR)

AN: EJ472999
AU: Aponick,-Nancy
TI: **Linking Teachers and Students across Networks.**
PY: 1993
JN: Computers-in-Libraries; v13 n9 p56-58 Oct 1993
AV: UMI
AB: Describes PALL (Pennsylvania Learning Link), an interactive computer system that offers research resources, electronic mail, discussion centers, distance learning information, access to Internet mail, and specific curriculum resources geared toward classroom needs. Regional services, statewide services, and classroom services are described, including Linknet, a consortium of public television stations and educational agencies. (LRW)

AN: EJ471260
AU: Eisenberg,-Michael-B.; Ely,-Donald-P.
TI: **Plugging into the "Net."**
PY: 1993
JN: Emergency-Librarian; v21 n2 p8-16 Nov-Dec 1993
AV: UMI
AB: Explores the educational benefits and applications of computer networks in elementary and secondary school classrooms, presents the basics for getting started, and introduces a sampling of networks with offerings for teachers and students. Highlights include electronic mail, file transfer, computer conferencing, information access, and future possibilities. A glossary is included. (Contains 22 references.) (LRW)

AN: EJ471223
AU: Descy,-Don-E.
TI: **Where to Start: An Internet Resource Guide.**
PY: 1993
JN: TechTrends; v38 n5 p39-40 Oct 1993
AV: UMI
AB: Provides an annotated list of 13 sources of information on the Internet, including 5 books, 4 online resources, and a novel. Works include introductory materials, technical manuals, and a guide especially for elementary and secondary school teachers. Three new services on the Internet are also described. (LRW)

AN: EJ471130
AU: Descy,-Don-E.
TI: **The Internet/School Connection.**
PY: 1993
JN: TechTrends; v38 n4 p15 Sep 1993
AV: UMI
AB: Discusses changes in the Internet, including new e-mail addresses. Several new discussion groups are described, including groups that encourage participation by kindergarten through grade 12 students, parents, teachers, and administrators; one concerning curriculum issues; and one exploring educational potentials of the Internet. (LRW)

AN: EJ470293
AU: Noden,-Harry; Moss,-Barbara
TI: **Virtual Schools: Reading and Writing (Professional Development).**
PY: 1993
JN: Reading-Teacher; v47 n2 p166-68 Oct 1993
AV: UMI
DE: Elementary-Secondary-Education; Foreign-
AB: Argues that the true benefit for students of school projects that use E-Mail to communicate electronically with students worldwide is not the added knowledge of technology but that the student gains in reading and writing. Discusses traveling the Internet via FrEdMail and Learning Link. (SR)

AN: EJ465823
AU: Valauskas,-Edward-J.
TI: **Education Online: Interactive K-12 Computing.**
PY: 1993
JN: Online; v17 n4 p89-91 Jul 1993
AV: UMI
AB: Suggests imaginary and currently possible uses of computers to keep children's curiosity alive and improve teaching. A sixth-grade dinosaur project involving a schoolwide network, compact discs, and e-mail is described as a fantasy. Real examples include using KIDSPHERE on the Internet and electronic networks for language, geography and science. (six references) (EAM)

AN: EJ464408
AU: Harris,-Judi
TI: **Mining the Internet: Using Internet Know-How to Plan How Students Will Know.**
PY: 1993
JN: Computing-Teacher; v20 n8 p35-40 May 1993
AV: UMI
AB: Describes 15 types of educational telecomputing activities that can be integrated into students' academic explorations. Three categories of activities are presented: (1) person-to-person communications, including LISTSERV discussion groups and electronic mail; (2) information collections, such as database creation; (3) and collaborative problem solving. (KRN)

AN: EJ464350
AU: Meizel,-Janet
TI: **High School Education and the Internet: The Davis Senior High School Experience.**
PY: 1992
JN: Resource-Sharing-and-Information-Networks; v8 n1 p127-40 1992
AB: Outlines the importance of sharing information resources for the intellectual development of high school students and describes cooperation between Davis Senior High School and the University of California at Davis to provide high school students access to the Internet and other information networks. Applications for students, classrooms, and teachers are described. (LRW)

AN: EJ461942
AU: West,-Peter
TI: **The Mother of All Networks.**
PY: 1993
JN: Teacher-Magazine; v4 n4 p19-22 Jan 1993
AV: UMI
AB: Many teachers use Internet, a vast international network of computer networks that links thousands of users in over 40 countries worldwide. This article describes the experiences of teachers in several middle and high schools. (SM)

AN: EJ446262
AU: Patrick,-Doyle
TI: **K-12: Linking to the National Networks.**
PY: 1992
JN: Computers-in-Libraries; v12 n5 p61-62 May 1992
AV: UMI
AB: Discusses the possibilities of linking elementary and secondary schools to the INTERNET. The use of technology to improve education by gaining access to greater amounts of information is described; costs associated with joining INTERNET are considered; and possible sources of funding for joining are suggested. (LRW)

AN: ED372772
AU: Kurshan,-Barbara-L; And-Others
TI: **An Educator's Guide to Electronic Networking: Creating Virtual Communities.**
CS: ERIC Clearinghouse on Information and Technology, Syracuse, NY.
PY: 1994
AV: Information Resources Publications, Syracuse University, 4-194 Center for Science & Technology, Syracuse, NY 13244-4100 ($10, plus $2 shipping and handling).
NT: 120 p.; Revised and updated.
PR: EDRS Price - MF01/PC05 Plus Postage.
AB: This guide provides a framework to help think about, choose, create, and design an electronically

networked community. It is written for educators and educational entities involved with the design and implementation of educational projects. The guide will help planners and designers decide what type of networked community to create; what factors to consider in selecting an electronic network to support the community; what networks or network projects already exist to provide resources to meet the needs of the community; and how members could gain access to the network. Chapter 1 introduces some basic concepts about networked communities and relates these concepts to education. Chapter 2 identifies criteria for selecting a network, beginning with its educational purpose and concluding with connection considerations. Chapter 3 describes types of networks, characterized by factors and issues relevant to decision making. Chapter 4 presents examples of networked communities in terms of the frameworks and factors defined in the preceding chapter. Included in the appendices are descriptions of networks and/or projects mentioned; comments on the future of networking in the schools; and a glossary. (Contains 28 references.) (JLB)

AN: ED372758
AU: Morgan,-Nancy-A.
TI: **An Introduction to Internet Resources for K-12 Educators. Part II: Question Answering, Listservs, Discussion Groups. ERIC Digest.**
CS: ERIC Clearinghouse on Information and Technology, Syracuse, NY.
PY: 1994
AV: ERIC Clearinghouse on Information and Technology, 4-194 Center for Science and Technology, Syracuse University, Syracuse, NY 13244-4100 (free while supplies last).
NT: 4 p.; For Part I, see IR 055 114.
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: The Internet is a vast computer network that consists of smaller interconnected computer networks. As K-12 schools connect to the Internet, a new means of communication opens up to educators and students. This digest describes some sample services and resources available to the K-12 community via electronic mail. Information sources covered in this digest are question answering services, including AskERIC; listservs or electronic discussion groups; and Usenet newsgroups, an electronic bulletin board system. (Contains 9 references.) (JLB)

AN: ED372726
AU: Honey,-Margaret; McMillan,-Katherine
TI: **Case Studies of K-12 Educators Use of the Internet: Exploring the Relationship between Metaphor and Practice.**
CS: Education Development Center, New York, NY. Center for Children and Technology.
PY: 1993
NT: 22 p.
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: The kinds of representations and associations that elementary and secondary educators are building of the Internet and the ways in which these representations vary depending on their use were studied. Subjects were teachers from the Center for Technology in Education (New York) national telecommunications survey who had responded that they used the Internet for more than just electronic mail. Participants were sent an open-ended questionnaire that covered Internet use, involvement, learning, use in schools, future, and background. Responses were received from nine women and nine men who had spent an average of 19 years working as educators. Half were classroom teachers, two were librarians, and the others were technology specialists at classroom or administrative levels. All but two of the interviews were conducted over the Internet. Responses indicate that obstacles to Internet use for elementary and secondary education are substantial. These users were extremely technologically sophisticated and were drawing on skills they had developed outside their professional roles as teachers. They also were in schools with the necessary technology—conditions not available for the majority of teachers. Suggestions are given for making the Internet more accessible and more friendly for the educator user, as well as for expanding the available technology. (Contains 28 references.) (SLD)

AN: ED370531
AU: Lam,-Kwan-Yau
TI: **Educational Resources on the Internet.**
PY: 1993
NT: 14 p.; Paper presented at the Annual Meeting of the Mid-Western Educational Research Association (October 1993).
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: The purpose of this paper is to introduce to school teachers and students resources on the Internet, and to provide updated information on selected resources. Following background information on the development of the Internet, its educational potentials are discussed, including resources for preparation of teaching materials, access for children to real-world learning resources, and uses in educational research. Internet usages in educational settings, including electronic mail, Telnet, and File Transfer Protocol (FTP) are then described. Descriptions and access information for several special interest discussion groups, electronic journals/newsletters, Telnet sites, and FTP sites are provided. (MES)

AN: ED369595
AU: Werner,-Judy
TI: **Reaching Out to the World: Training Teachers To Integrate Telecommunications into Special Education Classrooms.**
PY: 1994
NT: 8 p.; In: Montgomery, Diane, Ed. Rural Partnerships: Working Together. Proceedings of the Annual National Conference of the American Council on Rural Special Education (ACRES) (14th, Austin, Texas, March 23-26, 1994); see RC 019 557.
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: Rural special education teachers frequently are distant from information resources found in large urban libraries and universities, and do not have easy access to professional support or consultants' expertise. Telecommunications offers new sources of support to these teachers by permitting them to

send and receive electronic mail messages, take part in electronic conferencing, access special interest groups and bulletin boards, and retrieve information from on-line databases. However, few teachers, particularly those in smaller school systems, have the skills necessary to use this new technology. In addition, teachers in isolated settings have difficulty accessing traditional training sources. This paper describes a structured teacher training module that can be used by rural teachers, individually or in staff development workshops. Rather than teaching computer and telecommunications skills as an isolated subject, this module focuses on integrating all skills into the curriculum and relating their uses to the special education classroom. Its step-by-step structure allows each trainee to interact independently with the technology. Module sections cover telecommunications hardware, software, barriers to implementation in the school, and integration in content areas. Sample activities illustrate the use of E-mail, Internet resources, on-line library services, and bulletin boards. (Contains 21 references.) (SV)

AN: ED369385
AU: Caudell,-Lee-Sherman, Ed.
TI: The Global Classroom. Special Report: Online for Learning.
CS: Northwest Regional Educational Lab., Portland, Oreg.
PY: 1994
JN: Northwest-Report; Feb 1994
NT: 14 p.
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: This special report's feature article, "The Global Classroom," focuses on the ways the Internet makes the global classroom possible by allowing children to communicate with others around the world. To facilitate use of the Internet, the Northwest Regional Laboratory (NWREL) has plugged into the network and will be offering guidance for users and a "gopher" to find Internet resources. Several case studies are presented of children's use of the Internet in the northwestern United States. The enormous potential of computers for education is beginning to be realized in the area. Other articles in this issue include: (1) "K-12 Educators and Students Trade Information on Electronic Bulletin Boards" (derived from the "ERIC Review," Winter 1993); (2) "Linking N.W. Schools to the Internet" (Lee Sherman Caudell); (3) "Telecommunications Terminology" (derived from the "ERIC Review," Winter 1993); (4) "Learning Physics in Bits and Bytes"; and (5) "Out Front in the Outback" (Tony Kneidek). (SLD)

AN: ED369101
AU: Hill,-Elaine-N.; Whitaker,-Elaine-E.
TI: The Multicultural E-Mail of High School-College Collaboration.
PY: 1994
NT: 6 p.; Paper presented at the Annual Meeting of the Conference on College Composition and Communication (45th, Nashville, TN, March 16-19, 1994).
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: A collaboration between a university English professor and a high-school English teacher was successful in building community, yet rather unsuccessful in manipulating the Internet. Their collaboration worked, as far as it did, because of an absence of hierarchy. To create a basis for comparison with other studies, analysis of the collaboration can be anchored by a list compiled by Paul Wangemann in his dissertation concerning successful collaboration. Cultural differences in the institutions made for day-to-day interference in collaborations: the calendars of high schools and universities do not match; the nature of instructional contact does not match; and accountability differs at the high school and college level. Particularly in the case of collaboration involving the Internet, sources of authority tend to lie outside the classroom, and classroom leaders now more frequently model the role of the active learner. (Contains 18 references and an outline of the criteria for successful collaboration developed by Paul Wangemann.) (RS)

AN: ED368359
AU: Noguchi,-Kay
TI: Internet 101.
CS: Pacific Region Educational Lab., Honolulu, HI.
PY: 1993
AV: Pacific Region Educational Laboratory (PREL) Publications, 828 Fort Street Mall, Suite 500, Honolulu, HI 96813.
NT: 7 p.
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: The Internet, a worldwide network of computer networks, is a noncommercial service with acceptable use restricted to the advancement of education and research. Although it has been in existence for quite a while, it is still new to most elementary and secondary educators in the Pacific region and elsewhere. This report is an introduction to the Internet and global networking. Pacific-region education faculty have access to the Internet through the University of Guam and the University of Hawaii and will soon have access through the PEACESAT (Pacific Educational And Communication Experiment by SATellite) project, a partner with the Pacific Region Educational Laboratory. Basic Internet applications are described, including electronic mail, remote login, and file transfer. Real life examples are given of the ways in which elementary and secondary school teachers can use the Internet. These include professional use by teachers and use by students in discussion groups through electronic mail. Prerequisites for Internet use are described. (Contains 16 references.) (SLD)

AN: ED359044
AU: Roempler,-Kimberly-S.; Warren,-Charles-R.
TI: Computer Networks for Science Teachers. ERIC CSMEE Digest.
CS: ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, Ohio.
PY: 1993
AV: ERIC Clearinghouse for Science, Mathematics and Environmental Education, 1929 Kenny Road, Columbus, OH 43210-1080. (First copy free, additional copies, $0.25 each.)
NT: 3 p.
PR: EDRS Price - MF01/PC01 Plus Postage.

AB: Formerly reserved for use by scientists, researchers, and computer buffs, computer networks now have capabilities that make them extremely useful to science teachers and their classes. This digest is designed to provide educators with some basic background on computer communications and to provide a few examples of computer networks that are easily available to them and their students. Topics discussed are: (1) the power of communication, (2) the advantages of electronic mail, (3) dealing with networking charges, (4) networks available to science teachers (Science Line, EcoNet, PSINets, Internet/BITNET, and ERIC OnLine), and (5) getting involved in computer networking. (PR)

AN: ED350985
AU: Wheeler,-Daniel-D.
TI: KIDLINK in War and Peace.
PY: 1992
NT: 29 p.; Paper presented at the Annual Conference of the American Educational Research Association (San Francisco, CA, April 22-24, 1992).
PR: EDRS Price - MF01/PC02 Plus Postage.
AB: This paper describes the KIDLINK Project, a worldwide e-mail exchange with children from 10 to 15 years of age, which was created as part of the 1990 Children's Cultural Week in Arendahl, Norway, by Odd de Presno, a Norwegian journalist and author of computer books. The goal of the project is to create a global dialog among as many children as possible. The KIDLINK project is now running on Bitnet LISTSERV at North Dakota State University and is directly connected to both Internet and Bitnet. This paper describes the separate mailing lists used by the project for different aspects of its work, i.e., the RESPONSE List; the KIDCAFE List; the KIDS-92 list; the KIDPLAN list; and the KIDPEACE list. KIDLINK in time of war during the Gulf War and KIDLINK in time of peace are compared, and many examples of messages sent by children and a graph of the volume of messages sent by children from January 1991 to March 1992 are appended. It is noted that KIDS-91 had 2,600 participating children from 31 countries. (ALF)

AN: ED348054
AU: Tennant,-Roy
TI: Internet Basics. ERIC Digest.
CS: ERIC Clearinghouse on Information Resources, Syracuse, N.Y.
PY: 1992
AV: ERIC Clearinghouse on Information Resources, 030 Huntington Hall, Syracuse University, Syracuse, NY 13244-2340 (free with stamped, self-addressed envelope while supply lasts).
NT: 4 p.
PR: EDRS Price - MF01/PC01 Plus Postage.
AB: The Internet is a worldwide network of computer networks. In the United States, the National Science Foundation Network (NSFNet) serves as the Internet "backbone" (a very high speed network that connects key regions across the country). The NSFNet will likely evolve into the National Research and Education Network (NREN) as defined in the High Performance Computing Act of 1991. For the Internet to exist, there must be connections between computers and agreements on how they are to communicate. These connections, which can consist of any of a variety of communication media or methods, are usually established within areas or regions by the particular networking organization with authority or economic interest in that area. The Transmission Control Protocol/Internet Protocol (TCP/IP) currently defines how Internet computers, from personal computers to mainframes, are to communicate. Electronic mail (e-mail) can be used by two Internet users to exchange messages with each other, distribute messages to a list of subscribers, support electronic discussions, or distribute electronic journals (e-journals). The Telnet facility for remote login enables computer users to establish connections with bibliographic databases, campus information systems of various universities, full-text databases, data files, and other online services. The File Transfer Protocol enables the user to transfer virtually any kind of file that can be stored on a computer from one Internet-connected computer to another. Tools such as Gopher, WAIS, and World Wide Web make information on the network easier to locate and use. Although the use of NSFNet has been limited to non-profit research and educational uses, dialogues have recently begun about commercialization and privatization of the its infrastructure. (10 references) (BBM)

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